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U.S. ARMY MICOM SCIENTIFIC and ENGINEERING SUPPORT

COMPUTATIONAL CAPABILITIES REQUIREMENTS ANALYSIS

STUDY REPORT

VOLUME I MANAGEMENT OVERVIEW

OCTOBER 31, 1985

Prepared For: Commander
               U.S. Army Missile Command
               ATTN: AMSMI-WPA
               Redstone Arsenal, AL 35898-5170

Contract No.:   DAAH03-85-C0032
Subcontract No.: SBA-3-85-1-6298

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Inter Systems, Inc.

86 1 13   119

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A16338	3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle) Scientific and Engineering Computing Requirements Definition and Analysis	5. TYPE OF REPORT & PERIOD COVERED ADP Study Report 1985-1995
	6. PERFORMING ORG. REPORT NUMBER N/A

7. AUTHOR(s) Bulcavage, Frank	8. CONTRACT OR GRANT NUMBER(s) DAAH03-85-C0032

9. PERFORMING ORGANIZATION NAME AND ADDRESS Inter Systems, Inc. 7630 Little River Turnpike Annandale, VA 22003	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS N/A

11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Missile Command ATTN: AMSMI-IM-SE Redstone Arsenal, AL 35898-5175	12. REPORT DATE 31 Oct 85; 15 Nov 85
	13. NUMBER OF PAGES 392

14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Same

18. SUPPLEMENTARY NOTES

DA307476 (Agency Accession No.)

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Evaluation; Command; ADP; Technical; System Analysis; Requirements Definition;
Telecommunications; Network; Computer; Software; Training; Cost Effective;
Distributed Processing; Scientific and Engineering.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The basic questions addressed were what is the total near and long-term
scientific and engineering computing requirements and what is the best way to
effectively meet the requirements. The study identified and analyzed the re-
quirements, developed alternatives for satisfying the requirements, and
recommended cost effective approaches to satisfying the near and long-term
requirements. The findings and recommendations were presented in an Executive
Summary, Management Overview, and a Requirements Analysis Technical Report.

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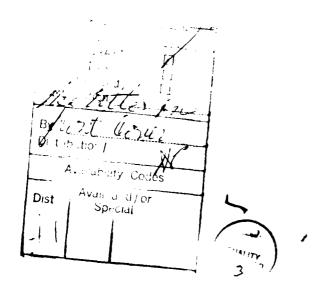COMPUTATIONAL CAPABILITIES REQUIREMENTS ANALYSIS

STUDY REPORT

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1.0 MANAGEMENT OVERVIEW

1.1 Background Information

Inter Systems, Inc. (ISI) was selected by the U.S. Army Missile Command (MICOM), to conduct a command-wide Scientific and Engineering Computing Requirements Analysis to assess the command's current, near-term (5 years) and long-term (10 years) scientific and engineering computing requirements; to analyze technical approaches and alternatives; and to develop a Master Plan and Implementation Strategy aimed at meeting the requirements in a cost-effective and forward-looking manner. The study effort began in February 1985. The data collection process was terminated during August 1985. The final report was delivered during October 1985.

The study analysis report is broken down into two volumes for management convenience. Volume I addresses the management and technical information in a summary fashion that is directed towards executive level management. It covers the study objective, methodology, limits of the analysis, summary of the findings, a quantification of the requirements, an analysis of the system alternatives, a summary of the recommendations, the master plan and implementation strategy, and the life cycle cost estimates. Volume II is a detailed technical presentation of the results of the study. It includes an analysis of the current environment, a brief investigation of the past and a look into the future. From this analysis, a definition of the overall problem was formulated. Then, the requirements were analyzed and quantified. The system implementation alternatives were then presented and specific current, near, and long-term recommendations were made. All of this supporting information was used as input to the Development of the Master Plan and Implementation Strategy from which supporting life cycle implementation

costs were estimated.

1.2 Study Objective

The primary objective of the study was to analyze and determine the total Scientific and Engineering computing requirements of MICOM and to determine the best way to satisfy these requirements over the near and long term. The secondary objective was to develop general hardware, software, telecommunications, system implementation, training and support recommendations and cost estimates. Although the resistance to the data collection effort was quite high, the information gathered was adequate enough to fulfill the overall study objectives, when supported by the professional judgment and technical expertise of the contractor.

1.3 Study Methodology

Several meetings were held with MICOM representatives to determine the overall study methodology. After some deliberation, the following guiding parameters were agreed upon:

a. The Management Information Systems Directorate (MISD) would notify the Project Management Offices and Functional Directorates of the scope and nature of the study effort and request primary and alternate points of contact,

b. The data collection effort would emphasize face-to-face contact, with a cross-section of the User Community, in the form of interviews with individuals willing to cooperate with and contribute to this study effort. ISI would initially work with and through the "official" points of contact; and then, branch out to other means of contacting people and gathering data as we determined appropriate to keep the study on schedule,

c. The actual collection of data would be somewhat standardized by

the use of survey instruments which would permit responses to both fixed and open-ended questions,

        d. A three-dimensional analytical approach would be developed to collect data from an organizational perspective, from a computer-application perspective, and a user perspective,

        e. Frequent participation in informal meetings regarding study progress and problem solving sessions would be required,

        f. Periodic written status reports were volunteered by ISI to document progress and problems,

        g. A mid-term and a final formal briefing were also required,

        h. The final report needs to be completed within six months after contract award.

MISD distributed a Disposition Form (DF) to twenty-three designated MICOM organizations on 27 February 1985. The DF introduced the purpose of the study, explained that a contractor would conduct the study, stressed the need for knowledgeable and proper people to be made available to participate in the data collection effort, and requested primary and alternate points of contact to be provided to AMSMI-WS by 8 March 1985. A copy of the DF is included in APPENDIX A. Many organizations responded with points of contact by the prescribed deadline. Some responses came in during the next two weeks and the remainder trickled in until the last one was received on 2 April 1985.

ISI developed two questionnaires during the period 15 February - 8 March. The ORGANIZATIONAL FUNCTION AND NEEDS ANALYSIS QUESTIONNAIRE and the SYSTEM APPLICATION SOFTWARE ANALYSIS QUESTIONNAIRE, survey instruments were field tested during the month of March. The last revision dates of the Organizational and Application level questionnaires were 27 March and 7 March,

respectively. A copy of the survey instruments is included in APPENDIX B.

The Organizational level questionnaire consisted of twenty questions organized into four discrete sections. The first section: POINTS OF CONTACT solicited both government and contractor personnel who might be contacted to provide information relevant to the study effort. The second section: SIZE AND COMPLEXITY OF THE SCIENTIFIC AND ENGINEERING USER COMMUNITY sought information regarding the current and future size of the User Community and the distribution of that community across level of hardware utilized, Engineering disciplines and MACARS specialty categories. Additional information, about the types of Scientific and Engineering computations that are currently performed or will be performed in the future and the current and future computer applications, was requested. The third section: ORGANIZATION PROBLEMS AND SENTIMENT was designed to capture information on the problem areas confronting the organizations and their management; and to develop some measurement of the level of understanding of their needs and the level of satisfaction with their computing environment. The fourth section: CURRENT AND FUTURE REQUIREMENTS attempted to collect information concerning automation plans as they relate to manual or semi-automated applications, to assess the current and future anticipated hardware/software combinations used or required, and to develop a current equipment inventory and future hardware and telecommunications requirements, along with anticipated costs. Data on training requirements, MISD services required and organizations plans for developing/expanding their own data processing capabilities was requested. A feedback sheet was provided to allow the organizations/individuals being interviewed to comment on the conduct of this study effort.

The Application Level questionnaire also consisted of twenty

questions. We requested information to identify the application name, its purpose and functional capabilities, the developmental history of the application, the availability and adequacy of formal documentation, which computer it is executed on and how much it costs, which programming languages it is written in, which software packages it is dependent upon, what type of computer peripheral devices are used during an execution, along with any special devices required for input/output processing. We tried to determine what percentage each of functional features of the application system were executed in a batch, interactive or real-time environment. We tried to identify User groups for each application, along with various computer workload statistics. Information was requested on the adequacy of training provided for the application and the adequacy of the ADP support. We attempted to identify specific hardware, software and telecommunications capablities that are required to improve the operation of the applications; identify the major problems with the applications, probe into the plans for resolving the problems and determine the type of services that MISD should be providing now and in the future. A feedback sheet was also included as part of Application level questionnaire.

During the period 15 February - 2 April 1985, ISI contacted representatives of twenty-five (25) MICOM organizational elements for an introduction to the survey participants and to explain the nature of the study and the types of questions to be asked. During these initial interviews, ISI tried to learn about the organization structure and mission of each office symbol at the Program Management Office, Functional Directorate and Staff Office level. ISI also gauged the level of interest and individual initial responsiveness observed by the interviewers; and, subsequently, developed target organizations to concentrate on, ranked by probability of having

Scientific and Engineering Computing requirements and by anticipated level of cooperation. As fate would have it, it turned out that the organizations with the most anticipated S&E Requirements initially provided the most resistance to the data collection effort. Perseverance on the organizational level data collection effort, during the period 1 March - 28 June 1985, eventually yielded at least some usable data on 107 sub-organizational elements of MICOM.

During the period 7 March - 2 August 1985, ISI concentrated on the Application level data collection effort. We attempted to distribute Application level questionnaires to individuals identified in the Organizational level questionnaires from: Question #7 Application Inventory and Question #10 Manual Applications. We also utilized the "Do you know of anyone else who could fill one out" technique, the telephone book and a MISD provided User list to seek out more application information. Ultimately, we collected data on only 70 application level questionnaires. Some of the data collected was not very useful, because people just didn't know the details of the applications. Some people interviewed just ran the application and were not experts on the application. Other people simply could not spend the amount of time required to obtain the necessary information and simply provided whatever they could.

By mid-June 1985, we realized that the volume and quality Application level data was not sufficient for reliable analysis and results. So, we revised the User Level questionnaire to capture some of the information necessary to perform an analysis of the near and long-term MICOM requirements.

The purpose of the User level questionnaire was to collect some

information directly from individuals, who use computers in the performance of their job functions. The hope was that additional useful information would surface directly from the User Community: on the types of applications that require better hardware and software support, specifics of hardware and software requirements, the variety of computer applications that a person works on, the number of applications that currently exist, and the number of applications expected to be developed over the near and long-term. Questions were also asked: to identify the MACARS Professional/Technical Specialty areas that are supported by computer applications, to identify and discuss problem areas, and, to solicit suggestions on approaches to resolving the problems that people are experiencing. Finally, we again asked for additional points of contact who are heavy Scientific and Engineering Computing Users.

The User level questionnaires were distributed and collected during the period 2 July - 2 August 1985. The initial distribution of User level questionnaires was targeted towards the organizations who had been less cooperative, or, who had provided less detailed information previously. Then, the distribution and collection process was directed towards more cooperative individuals across the twenty-five major organizations that were being covered by this survey. In the end, we collected only 148 User level questionnaires, which were used as a representative sampling of the Scientific and Engineering User Community.

In parallel to the data collection effort, a considerable amount of time was spent attempting to improve the quality of the data being collected. This was accomplished by extensive daily review of the data collected for accuracy and consistency. This review took place at both the individual questionnaire level (i.e., organizational, application, and user), and across

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matching questionnaires for a given organization (i.e., cross-check the Army Missile Laboratory System Simulation and Development Directorate's organizational questionnaire vs. their applications vs. their user level questionnaires). We attempted to resolve gross inconsistencies by multiple follow-up interviews, lengthy telephone conversations and our own judgment. The questionnaires had been designed to be both self-checking, cross-checking and complementary to each other. Thus, a sufficient amount of data was collected to support the analysis of the overall MICOM requirements. However, better cooperation and more accurate data would have improved the data collection process.

Efforts were made to acquire historic computer workload information, but only the MISD S&E Computing Center kept any meaningful historic workload information. We were informed that most of the small computer centers within MICOM did not have their accounting systems "turned-on" or did not keep more than a couple of months worth of data. So, historic workload information was collected only for the S&E Center.

During the months of June and July, we were able to construct a database containing MISD S&E Computing Center workload information from fiscal year '78 through the month of June 1985. The database contains monthly data on both the CDC 6600 and CYBER 74 machines, for both billable and non-billable resources consumed. The types of data in the database include the following:

CP SECONDS	- Central Processor Computer Time in Seconds
CP-RT SECONDS	- Central Processor Real Time Seconds
IO SECONDS	- Input/Output Time in Seconds
CM UNITS	- Core Memory Units in Kiloword Seconds (KWS)
ECS UNITS	- Extended Core Storage Units in KWS
CARDS READ	- # Cards Read
WORDS INPUT	- # Words Input
CARDS PUNCHED	- # Cards Punched
WORDS PUNCHED	- # Words Punched
LINES PRINTED	- # Lines Printed

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WORDS PRINTED          - # Words Printed
TAPES REQUESTED        - # Tapes Requested
ICOM CONNECT SECONDS   - Intercom Interactive Terminal Connect Seconds
DDS CONNECT SECONDS    - DDS Console Connect Seconds
BATCH JOBS             - # Batch Jobs by Priority 1 to 7
TOTAL PP UNITS         - # Total Peripheral Processor Units
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Also included in the database was a measurement of the equivalent System Hours for some of the categories mentioned above and Total System Hours. This historic computer utilization data, along with data taken from the Organization and Application level questionnaires, served as the inputs to the workload analysis performed for this contract.

Considerable time and effort was expended during the months of May through July to develop the data processing system to process the data collected on the questionnaires. Many databases were created to handle the data from selected questions. Procedures to enter and edit the data were developed as necessary, as well as procedures to simply print out the data in a format similar to the questionnaire itself, for data verification purposes. As the databases became sufficiently populated, exploratory tabulation procedures were developed to reduce the data collected into potentially useful information for the final report. After the databases were completely updated and finalized, the more interesting tables and graphics procedures were executed using the complete data. Information developed from these tables and graphs are found throughout the final report.

ISI did comply with the contractural requirements, the Statement of Work, and mutually agreed upon requirements. The first half of the study was conducted pretty much according to plan, although the data collection process proceeded along much slower than it had been expected. The mid-term briefing was held on 31 May 1985. The briefing covered the twenty-four topics identified in Figure 1-1. ISI produced written status reports and held

frequent meetings as required. The second-half of the study effort also went

pretty much according to the plan presented during the mid-term briefing,

although, the data collection process continued into August, and, additional

time was requested for analysis of the data collected and to complete the

final report. The draft report was delivered on 20 September 1985 and the

final report was delivered on 31 October 1985.

MID-PROJECT BRIEFING TOPICS FOR DISCUSSION

o DMIS Vision of Ideal S&E Computing Environment

o Present State of S&E Capability as seen from the Trenches

o Points of Conflict - Reasons

o Projections if no Changes are made

o Selection of Possible/Likely DMIS Objectives and Steps
  Necessary to Accomplish Them

o Current Progress Summary

o Problems Encountered During the Study

o Organization and User Perceptions of MISD

o Organization and User Needs Identified to Date

o Organization and User Problems Identified to Date

o Requirement Trends - Hardware

o Requirement Trends - Software

o Requirement Trends - Telecommunications

o Requirement Trends - Access

o Requirement Trends - Analyst Support

o Requirement Trends - Contractor Support

o Requirement Trends - Training

o Schedule/Milestones for Study Completion

o Application Areas Identified to Date

o Specific Applications Identified to Date

o Preliminary Evaluation of Long Range Direction

o Recommendations for MISD - Improving Services

o Recommendations for MISD - Immediate Action Items

o Recommendations for MISD - Study Completion

Figure 1-1   Mid-Term Briefing Agenda

1.4 Limits of the Analysis

The conduct of this study effort was hampered by the level of cooperation provided by the various MICOM organizations surveyed. Throughout the study, there was a definite lack of the perception that this was an important, high-priority effort. In some areas, there was a significant lack of technical knowledge regarding requirements. In other areas, there was both High-level and general Lower-level reluctance of people in various organizations to divulge information regarding needs, current capabilities and plans for the future. The short time period of six months for contract performance, which permitted roughly about four and one-half months for data collection, coupled with the normal interview scheduling problems and time delays caused by TDY, availability, meeting cancellation, rescheduling, etc., resulted in only an adequate level of data for analysis. We would have preferred to gather much more detailed information about the organization's requirements, their applications and their computer users, than we did.

The purpose of the study was to collect only S&E Computing requirements and this encouraged many of the Project Management Offices and Directorates to attempt to bypass the whole S&E line of questioning by claiming that all or most of their computer applications are "Business" related. The simple fact of the matter is that the PM Shops are the originators of Scientific and Engineering computing requirements that are satisfied by contractors, the MICOM Functional Directorates and their own staff members. The MICOM Functional Directorates also originate their own S&E Computing Requirements during their efforts to perform their Research and Development (R&D) missions. Many of these computing requirements are satisfied through a variety of means, including MISD S&E machines, MISD Business Machines, Non-MICOM government machines, commercial timesharing

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arrangements, contractor's machines and an organization's own computing capabilities. Collection of computer utilization statistics on all these providers of computing resources was not possible during the course of this study, but is something that should be investigated in the future, possibly as a follow-on study to this one.

The data collected at the organization, application and user level probably affords us only a peek at the true volume of actual S&E computing requirements that exist for MICOM. When the study began, the twenty-five organizations to be interviewed were composed of over 600 sub-organizations. We were able to collect organizational level data at predominantly the Directorate and Division level as opposed to the Branch, Section, Unit and Group levels. Therefore, we must assume that the data provided at the Directorate or Division level, even in the case of a large Directorate or Division (say, over 100 people), reasonably approximates the information requested with some degree of accuracy. Obviously, we would have preferred to talk with more people at the working level, to determine more of the needs from the "trenches".

The data collected at the application level for 70 specific applications or application areas from the twenty-five organizations was used as a representation of what some typical S&E applications look like. The general reluctance to provide information on applications was attributed to the fact that organizations quite simply do not want anyone else to know what they are actually doing. Also, they do not want to make it widely known about how much work is performed by contractors and by their own staff. In being so difficult, regarding application level data, MICOM has made our task of actual workload quantification almost next to impossible. But, using the MISD

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provided workload information, data gathered from the questionnaires, facts about historic events, little bits of information gathered from here and there, and future expectations, we developed some general quantification parameters regarding the overall MICOM Scientific and Engineering requirements.

The number of questionnaires collected at the User level from 148 MICOM users fell short of the desired number. We had hoped to get one or two User level questionnaires from each of the over 600 sub-organizations, but that never happened. We again ran into the myraid of excuses: we don't have computers or terminals, we don't use computers, we don't have any S&E Users, we only do business applications, everything is done by contractors, etc., etc., etc. It was quite an experience to later walk up and down the halls, peek into some rooms and see quite a variety of people working on quite an assortment of terminals, microcomputers, minicomputers, and other hardware devices. Nevertheless, although limited in scope, the Users provided some valuable insights to their needs; and hopefully, their needs are representative of the specific needs of the MICOM Scientific and Engineering User Community.

In summary, the MICOM Scientific and Engineering Computing Requirements Analysis was limited by the cooperation of MICOM Organizations and the time and funding constraints for contract performance. The interpretation of the findings of this study, the quantification of the requirements, the analysis of the systems alternatives, the recommendations, the suggested Master Plan and Implementation Strategy, and the Implementation Life Cycle Cost Estimates must be evaluated within those constraints.

1.5 Summary of the Findings

The immediate computing needs of the MICOM Scientific and Engineering Community are currently _not_ being met by the existing cadre of obsolete computer hardware, software capabilities, and telecommunications capabilities that exist on Redstone Arsenal. Immediate actions must take place to improve the Scientific and Engineering Computing Environment, both at the central computing facility and down through the User level. Significant long-term strategic planning and implementation activities must take place to ensure that a productive work environment exists for the scientists and engineers over the next decade.

The revolutionary trends in the computer industry have created a new breed of computer users from a population of people who traditionally have viewed computers as some piece of machinery that programmers use to get results from. Now and in the future will be an ever increasing interest for individuals to use the computer as a tool to perform their jobs more efficiently and effectively, and to make their work more enjoyable. The total MICOM S&E Computing User Group population is currently estimated to be somewhere between 1600 and 2500 or a maximum of 28% of the total MICOM work force of 9000 people. The size of this community is expected to grow to somewhere between 1800 and 3200 Users over the near-term; and, between 3500 and 4000 Users over the long-term. This relatively significant increase in the size of the S&E User Community will create a demand for significantly more terminals, printers, plotters, microcomputers, minicomputers, mainframes and even some supercomputer usage. This demand for hardware will be coupled with an equally strong demand for more sophisticated software packages and extensive networking of all levels of hardware. These demands will trigger a very large demand for training and support services. In other words, there is

a crying need for TOTAL SUPPORT SERVICES for the Scientific and Engineering Community.

MICOM MISD has not aggressively pursued the concept of TOTAL SUPPORT for the Scientific and Engineering Community apparently, due to lack of sufficient staff and higher echelon emphasis on what seems to be predominately "Business Applications." As a result, the Scientific and Engineering Computing Users feel neglected. Based upon our observation of the situation, we must agree with the User's sentiment and surface this problem to Executive Level Management for their review, analysis and appropriate actions.

MISD must first accept the fact that the S&E User's needs are not being met; decide to do something about it; determine just how far MISD will go in attempting to identify and satisfy the User's needs; inform the Users about the plans regarding what will be supported, when, how and why; and provide assistance to the Users in developing their own support for areas which will not be completely supported. In taking the leadership initiative, MISD can in fact change its image from a <u>CANNOT DO</u> to a <u>CAN DO</u> organization. Strong leadership, a little bit of initiative and a MISD commitment to improving the availability of state-of-the-art hardware, software, telecommunications, training and support service concepts will go a long way towards fostering the spirit of cooperation, in meeting the S&E Computing Requirements, that is so desperately needed at MICOM.

Meeting the needs of the S&E community poses a difficult challenge to MISD management and to the MICOM Commander. The S&E User Community views MISD as a roadblock when they are trying to find solutions to their ADP needs. MISD is viewed as an "EMPIRE" building organization that doesn't really care

if the User's ADP needs are met. MISD services are too expensive to use and the services that exist are inadequate to meet the User's requirements. So, the S&E Users have sought out and found a variety of alternatives to what have been traditionally MISD provided services. The demand for MISD S&E Computing services has declined significantly over the past five years due to the high costs and relatively slow processor speed and lack of sufficient central computer memory. The trend to move applications away from the MISD S&E Computing facility will continue until more adequate hardware, software and support services are provided at a reasonable cost. If this trend continues, the S&E Computing facility will be forced out of business in twelve to sixteen months.

There are substantial non-tactical S&E and S&E related ADP/tele-communications requirements at MICOM. These requirements will grow in complexity as the weapon systems become more complex, and, as the sophistication level of the S&E Computing User Community follows technological advances in hardware, software and telecommunications. In addition, as analytical techniques migrate from two into three-dimensional analyses, the demands for large memory, faster central processor speeds and proportionally higher data transmission rates will become commonplace. The MICOM Commander and MISD management must be made aware of the anticipated future S&E requirements and take appropriate actions to see that the long-term needs of the S&E Community are met in a cost-effective and forward-looking manner.

There are substantial problem areas at MICOM that have surfaced during the course of this study. The major problem areas are presented here and then are discussed more thoroughly in the technical presentation of the results of the study which is contained in Volume II of this report. The

spectrum of problem areas covers problems with organizations like MISD, Procurement, Contractors, Manufacturers, and even with its own organization's internal structure and politics. It covers the technical aspects of hardware, software, telecommunications, networking system integration and office automation. It spans the critical areas of technical support services, hardware and software acquisition and maintenance, training and consulting. It contrasts the impacts of information technology against the traditional management functions of planning and control. It encompasses the issues of efficiency and productivity as they relate to the human beings who are the Users, the people who need to get the work done.

Problems most frequently leveled at MISD include:

o   Cost of services are too expensive

o   Inadequate hardware: lack of large central memory capacity, relatively slow CPU hardware, slow disk drive, tape processing problems (slow, cheap tapes, tape library operations), lack of virtual memory capability, lack of sufficient disk space (both permanent and temporary storage)

o   Inadequate software: software doesn't support virtual memory, poor software or lack of adequate software support in the areas of: Database Management, Graphics, Spreadsheet, Office Automation, Engineering (Aerospace, Electrical, Chemical, Civil, Industrial, Mechanical, Nuclear and Structural), Programming Languages, Scientific Software Libraries, Simulation/Modeling Languages, Statistical Analysis, Word Processing and Computer Assisted Design, Engineering and Manufacturing

o   Inadequate telecommunications: slow data transmission speeds, lack of communication ports, lack of networking support,

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reliability not good

o Documentation: not provided, non-existent, years out of date, not adequate for User's needs

o Training: little if any is formally provided

o Support services: limited support services provided, don't provide operators, consultants, programmers, and technicians capable of dealing with the variety of S&E Computing equipment used at MICOM. Turnkey application development support not provided

o End-User hardware: desirable terminals, plotters, micros, printers, etc., not readily provided

o ADP Acquisition: acquisition support of ADPE geared towards "Business" and not S&E User Community needs

Criticisms most frequently directed towards Procurement include:

o Acquisition cycle is too long and involves too much paperwork

o Acquisition process is not cost-effective, savings on the actual procurement is considerably less than the time, effort, energy and frustration associated with the paperwork and approval process

o Large procurements get all the attention of management. Small ticket items needed for Scientific and Engineering work day-to-day operations are not procured in an efficient manner. Sometimes scientists and engineers must wait weeks or months for items they needed yesterday

o Procurement people do not understand the difference between scientific instrumentation and computers

o   Procurement needs some people with Scientific and Engineering
    backgrounds to help them acquire S&E laboratory equipment

Problems associated with contractors include:

o   Some of the major contractors provide reams and reams of
    computer printouts to the Project Offices, who in turn provide
    the same to the Functional Directorates, who manually sift
    through the computer printouts to extract necessary data for
    analysis. This is clearly a waste of valuable and expensive
    engineer time.   The data should be provided in a machine
    readable form or via electronic data transfer capabilities that
    are available off-the-shelf.

o   Because MISD doesn't provide more extensive End-User application
    area support, many organizations go through considerable effort
    and paperwork to obtain contractor support services. When a
    contractor, acquired through the competitive procurement process
    isn't performing the job properly; the organizations usually
    keep the contractor around because it is too difficult to obtain
    a replacement contractor.

o   The Project Management Offices have experienced high contractor
    personnel turnover rates on some of the body-shop type support
    contracts that have existed in the past or still exist. The
    training of new contractor personnel is very time consuming and
    takes time away from other duties.

    MISD could be providing some services in these areas if some
    expertise were developed in the End-User application areas. A
    team of rapidly deployable fire-fighters and consultants could
    be called upon to help out the Users in their time of need.

Problems associated with the hardware and software manufacturers include:

o   The training provided by the vendors on the hardware and software is often either too simple or too complicated to be useful. The training is not customized or tailored to the User's application area nor skill level.

o   Too much travel is involved in vendor-provided training programs, or is too expensive to be done on-site at the Arsenal.

o   The hardware manufacturer's maintenance is considered to be good to excellent. The users consider the RASA contractor provided maintenance services to be almost as bad as not having any maintenance services at all. Complaints of frequent down-times of User's hardware were openly expressed.

o   Vendor provided software maintenance and hotline support is fine, but not as desirable as locally provided face-to-face problem solving support services.

o   Acquisition of spare and repair parts and required supplies is not easy to accomplish due to contracting procedures. Often acquired items are not adequate to meet the Users' needs. Sometimes items are substituted that are not even useable. Mechanisms are required to get these items directly from responsible vendors.

Problems associated with organizational structure and politics include:

o   Organizational elements of large organizations like the Missile Laboratories do not make it a habit of sharing their own computer resources with other elements of the same organization.

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But, they readily share them with the Project Offices (i.e., their customers) and their contractors.

o Most organizations, and, maybe MICOM as a whole, apparently do not have any formal Scientific and Engineering ADP Policy established.

o Many organizations have a critical shortage of properly-trained personnel who can deal effectively with state-of-the-art S&E hardware, software and telecommunications problems and issues.

o Some organizations have excess space problems, others have excessive space limitations to the point of creating a poor working environment for some members of the S&E community.

o Some organizations have more ADP equipment than they know what to do with; other organizations have so little ADP equipment that professional staff must "wait in line" in order to use it.

o Most of the Functional Directorates have difficulty in identifying future computing and manpower requirements partially because the Project Offices do not do enough long-term planning regarding their long-term requirements for computing and manpower services, and partially because they plan on doing more things on their own.

The comments and criticisms directed towards training include:

o The training provided through the Civilian Personnel Office (CPO) is too simple.

o The Learning Resource Center concept is good but lacks the staffing composed of experts who can provide the human element and touch to computer-based (PLATO) delivery of training.

o   The location of the Learning Resource Center makes it difficult
     to use because of travel time required to get there and back.
     Wider access to the Center in the form of a training network
     would be welcome, or wider distribution of microcomputers that
     run PLATO.

o   There is no apparent commitment on the part of mid-management to
     utilize training as a method of improving productivity. Top
     management must take the initiative in this problem area in the
     interest of overall productivity improvements that can be
     achieved by adequate training.

o   Allocation of time for training is discriminatory towards
     professionals. Administrative personnel apparently do not have
     the same training opportunity and thus cannot be used to assist
     scientists and engineers in some of the "Data" related chores of
     S&E work.

1.6 Classification and Quantification of the Requirements

The requirements identified during the course of the study fall into the broad categories of HARDWARE, SOFTWARE, TELECOMMUNICATIONS, ACCESS, ANALYST SUPPORT, CONTRACTOR SUPPORT and TRAINING. Observations regarding the trends for each of these categories are presented in this Section. The observations are followed by additional discussions of the requirement areas and quantification information is provided where sufficient data was provided for analysis.

REQUIREMENT TRENDS - HARDWARE

o Strong desire to utilize more minicomputers and microcomputers.

o Plans to use minis and micros for prototyping S&E applications and then use mainframes for large production runs.

o Need for larger memory capacities on all levels of hardware to handle complex software packages.

o Strong desire to acquire many minis and micros.

o Strong desire to acquire faster color graphics devices.

o Strong desire for CAD/CAM hardware and supporting software.

o Strong need for storage and retrieval of engineering drawings.

o Continuing need for faster computers to solve more complicated problems.

o Small need for Supercomputer time now, but a tremendous growth in the demand for Supercomputer time will develop in about five years as the S&E User Community expands and realizes the benefits of this class of computers.

o Strong need for faster local peripheral devices to keep up with faster terminals and microprocessors connected to various levels of hardware.

o Strong desire to have state-of-the-art hardware at the Central Computing Facility.

o Strong need to develop long-term hardware acquisition plans so the Users know what to expect, and at what price.

o Strong need to avoid system saturation problems due to acquisition of inadequate hardware or lack of adequate capacity planning and capacity management.

REQUIREMENTS TRENDS - <u>SOFTWARE</u>

o   Strong desire to acquire canned software packages to perform
    work being done currently in various programming languages.

o   Increasing demand for programming languages like ADA, C, PASCAL.

o   DBMS, Graphics, Spreadsheet and Office Automation software
    needed the most.

o   Engineering Packages desired in Electrical, Chemical,
    Industrial, Mechanical, Nuclear and Structural Engineering
    Disciplines.

o   The demand for Project Management Packages, Statistical Analysis
    Packages, Simulation/Modeling Languages, Word Processing
    Packages and PC Communications Packages is constantly
    increasing.

o   Scientific Software Libraries and Codes will always be needed.

o   Emerging demand for CAD/CAM software is evident in many
    organizations.

o   Standardization of Local Area Network Software is a must.

o   Strong desire for user friendly software packages and
    application development software tools.

o   Users are not familiar with many commercially-available software
    packages.

o   Potential Users need to be educated to the capabilities
    available in various software packages.

o   Users need assistance in determining which software packages can
    be used to meet their needs.

o   Detailed software functional requirements analyses must be
    conducted soon to determine some set of standard-supported

REQUIREMENT TRENDS - <u>SOFTWARE</u>   (Contd)

software packages for the Command.

o   Software packages that are available across vendors machines and
    across levels of hardware are required, so the Users are not
    locked into any vendor's particular hardware.

o   Software packages must facilitate application transportability
    across operating systems, vendors machines and levels of
    hardware.

REQUIREMENT TRENDS - <u>TELECOMMUNICATIONS</u>

o   Need an Integrated Data Communication Utility Network to interconnect hundreds of computers and over one thousand terminals and hundreds of remote devices.

o   Trends towards distributed processing concepts using supercomputers, mainframes, minicomputers, and microcomputers will create a substantial telecommunications requirement over the next ten years.

o   Local Area Networks being created will need to talk to other Local Area Networks.

o   Wider access to DDN will be required. Some computers are scheduled to become or already are DDN Hosts.

o   Country-wide and worldwide Telecommunications requirements exist due to large geographic scale mission assignments. Satellite and microwave circuits will be required by some organizations in the future.

o   Complex data transmission issues exist regarding protocols to support and which local area networks to support.

o   Within MICOM Organizations both classified and non-classified processing requirements exist.

o   Communications links from MICOM Organizations to contractors sites are required by many of the Project Management Shops.

o   Contractor to Contractor data links are and will be required.

o   MICOM Organization to non-MICOM Organization Telecommunications requirements exist.

o   A network gateway to the Army Supercomputer Network is required.

o   Security issues and requirements must be carefully reviewed.

REQUIREMENT TRENDS - <u>TELECOMMUNICATIONS</u>   (Contd)

o   Classified and non-classified communications requirements might
    need to be addressed separately in independent networks.

o   Future increases in telecommunications network traffic might
    require the use of high-speed fiber optics data links.

o   MICOM utilizes over fifty different vendor's computers and over
    one hundred different vendor's types of peripheral equipment.
    The User Community expects that all these pieces of equipment
    will easily talk to each other.   Current and future technology
    will make this wish possible, but not without some planning
    effort to insure compatibility.

o   Networking support for CDCNET, IBM SNA, DECNET, HP ADVANCENET,
    SPERRYLINK, and other vendors networks is required.

o   Support for both full-duplex and half duplex, synchronous and
    asynchronous communications is required.

o   Support for a variety of communications protocols is required;
    including HASP Multi-Leaving, CDC UT200, 2780/3780, 3270 BSC,
    SDLC, HDLC, ETHERNET, OPENNET, X.25, UNISCOPE, and various other
    vendor's unique protocols.

o   Both dedicated and dial-up communications circuits are required
    at speeds from 300 to 9600 BAUD.

o   Local area network speeds up to 10 MBPS are required.

o   Megabyte through Gigabyte data links will be required in the
    future.

REQUIREMENT TRENDS - <u>ACCESS</u>

o   Organizations wanting MISD to provide terminals have, in the
    past, been told to get their own terminals; then they can access
    MISD computers. MISD is expected to provide turnkey access from
    providing the End-Users with terminals and peripheral equipment,
    microcomputers, minis and software and communications services.

o   Organizations have gone out and obtained their own terminals,
    micros, minis, and even mainframe computers. Now, they want
    this equipment to be connected to MISD computers via a local
    area network.

o   The User Community will increase mini, micro and outside
    computer resources utilization and use MISD computers only when
    absolutely necessary, unless MISD provides total support and
    turnkey services.

o   Unless computing access on the mainframes is provided at a
    cheaper cost, the access trend to other alternatives will
    continue.

o   As various organization's own computing capabilities get
    saturated, due to the expanding size of the User Community, the
    requirements for accessing MISD computing power will increase,
    if the pricing for the computer time is competitive.

REQUIREMENT TRENDS – <u>ANALYST SUPPORT</u>

o The tremendous growth expected in the size of the User Community should trigger a greater need for analyst support, but in a wider area of coverage.

o The required analyst support, will probably be in areas which MISD has not traditionally provided support, because of lack of interest or lack of resources available to provide such services, or lack of expertise.

o Areas requiring analyst support will include:

  o micro and mini hardware, software and telecommunications

  o User requirements analysis on mainframe, minis and micro levels of hardware

  o supercomputer support

  o studies

  o turnkey support

  o modern software support services

  o training support

  o User support and hand-holding

  o troubleshooting

  o support of non-MISD provided equipment

  o providing equipment maintenance services

  o mini and micro configuration development services

  o providing systems integration

  o providing application development and support services

  o providing local area networking analysis and support

  o maintaining a state-of-the-art Hierarchical Data Processing System for Scientific and Engineering Computing requirements

REQUIREMENT TRENDS - <u>CONTRACTOR SUPPORT</u>

o   Organizational information demands will generate the need for
    additional contractor support.

o   Contractors will continue to be used as vehicles to provide
    desired hardware and computer access that organizations desire,
    until MISD provides the same services at a reasonable price.

o   MISD will need extensive contractor support to satisfy the needs
    of an expanding User Community.

REQUIREMENT TRENDS - <u>TRAINING</u>

o   The expanding User Community will generate a large demand for training services.

o   Training requirements will encompass hardware, software, telecommunications, and application areas across mainframes, minis, micros and potentially supercomputers.

o   Users are seeking training services from other sources due to lack of appropriate, locally-provided, training; or, poor quality and poor delivery of training materials.

o   Users are seeking custom-tailored training that is relevant to their own application areas, which general purpose training courses don't come close to.

o   Users don't care who provides the training, but do care that the training meets their specific needs.

o   Custom training plans and programs must be developed to handle beginner, intermediate and advanced computer users in various functional areas. The training program must address both the computer end, and integrate appropriate subject matter examples and application level problems into the training materials.

o   There is significant interest in the training problem, but significant resources are not being directed at attempting to solve the problem. The Learning Resource Center concept and the use of PLATO must be expanded to meet the User's training needs. Currently the students are sent to the schoolhouse. The Users want the schoolhouse to be brought to them in the form of local training programs and wider access to PLATO training resources via a terminal network, along with local human support.

HARDWARE REQUIREMENTS

The study identified the need for more mainframes, minicomputers, microcomputers, word processors, terminals and associated peripheral devices; like printers, plotters, disk, tape, etc. In addition, some organizations indicated that a requirement for supercomputer time exists both now and over the long-term. Data provided on the Organizational Level Questionnaires indicated that there will exist at MICOM, by the end of FY 85, about 441 computers, 119 word processors and 437 terminals. Data obtained from the USADARCOM ADP Management Information System ADPE Inventory indicated that there may be an additional 281 computers at the MICOM Data Processing Installation (DPI). Reconciliation of the two sources of data was impossible to complete during the short duration of this study, so we must assume that there are between 441 and 722 computers at MICOM. Current plans indicate that a substantial amount of ADP equipment will be acquired over the next ten years. Figure 1-2 is a summary of the data provided on the questionnaires regarding computers, word processors and computer terminals. It shows the current inventory and planned acquisitions of hardware.

Follow-up data collection efforts with MICOM personnel, at the Application and User Levels, indicated that due to the Department of the Army (DA) microcomputer buy and the minicomputer buy that is being developed, the projected acquisitions of microcomputers and minicomputers could easily double or triple. The total number of minicomputers is expected to double and the total number of microcomputers is expected to triple.

CURRENT INVENTORY AND FISCAL YEAR PLANNED ADPE ACQUISITIONS

EQUIPMENT	85	86	87	88	89	90	91	92	93	94	TOTAL	# ADDED FY86-94
MAINFRAMES	19	1	0	0	0	0	0	0	0	0	20	1
MINICOMPUTERS	73	33	23	6	7	1	0	2	0	0	145	72
MICROCOMPUTERS	349	440	203	87	92	13	23	13	15	46	1,281	932
WORD PROCESSORS	119	23	18	7	9	4	1	1	1	1	184	65
TERMINALS	437	130	44	12	15	8	9	8	8	8	679	242

Figure 1-2 Hardware Inventory And Acquisition Plans

Using an average cost of $5,500,000 for mainframes, $600,000 for minicomputers, $60,000 for super microcomputers, $15,000 for PC microcomputers and $15,000 for word processors and $500 for terminals, estimates of currently-planned and likely-maximum purchase costs were developed for planned ADPE acquisitions. Figure 1-3 shows these estimates.

It can readily be seen that the majority of dollars are being spent on the minicomputer and microcomputer level of hardware. If the current ADP acquisition plans of the User Community are executed, MICOM will spend somewhere between 84 and 162 million dollars on ADPE and still not have adequate computing power. The ADP needs of the Users must be met, if MICOM is to perform its mission; but, the needs must also be met in a cost-effective and cost-efficient manner. Thus, a well-designed Distributed Hierarchical Data Processing System is needed to satisfy the requirements. The actual design of this system was not within the scope of this contract. Arguments can be made that the average cost estimates used are too high, but when one considers the whole process of hardware acquisition and piecemeal expansion of each system that is acquired, the figures used actually are quite conservative. It is fully anticipated that the same organizations, who are flocking to purchase the INTEL 310 machines to get the WYSE Personal Computers, will flock to purchase the more powerful minicomputers, when they too become easy to acquire. Thus, redundant expenditures on ADPE will cause the actual total expenditures to meet or even exceed the estimates presented in this report.

EQUIPMENT	FY86-94 ESTIMATED QUANTITY	ESTIMATED PURCHASE COST	LIKELY MAXIMUM ESTIMATED COSTS IF MINIS DOUBLE AND MICROS INCREASE	
			QUANTITY	COST
MAINFRAMES	1	$ 5,500,000	1	$ 5,500,000
MINICOMPUTERS	72	43,200,000	144	86,400,000
MICROCOMPUTERS (SUPER)	450	27,000,000	600	36,000,000
MICROCOMPUTERS (PC)	482	7,230,000	2,000	30,000,000
COMPUTERS SUBTOTAL		$ 82,930,000		$157,900,000
WORD PROCESSORS	65	$ 975,000	200	$ 3,000,000
TERMINALS	242	121,000	1,500	750,000
WP & TERMINALS SUBTOTAL		$ 1,096,000		$ 3,750,000
PLANNED ACQUISITION COST:		$84,026,000		$161,650,000

Figure 1-3 Hardware Acquisition Cost Estimates — Current Plans

SOFTWARE REQUIREMENTS

The survey discovered a significant requirement for a variety of software packages and programming languages. Some of the software packages and programming languages are currently in use at MICOM; others are desired, but not available on existing hardware. Many of the advanced software packages are not available on the current CDC hardware due to central memory limitations and lack of a Virtual Operating System. The software required falls into eleven broad categories: DATABASE MANAGEMENT SYSTEMS, ENGINEERING PACKAGES, GRAPHICS PACKAGES, PROGRAMMING LANGUAGES, PROJECT MANAGEMENT PACKAGES, SCIENTIFIC SOFTWARE LIBRARIES AND CODES, STATISTICAL PACKAGES, SIMULATION/MODELING PACKAGES, P.C. COMMUNICATIONS PACKAGES, WORD PROCESSING PACKAGES, and CAD/CAM and FACTORY AUTOMATION. Software in each of these areas is required across all levels of hardware, from the micro through the supercomputer level. Software packages are desired that run on more than one vendor's machine, and that run across levels of machines. Transportability of User applications from machine to machine is a strong requirement. Many new Computer Users, who were interviewed, expressed the strong need for someone to come into their organizations and look at their applications and potential applications and help them to determine what type of software packages they could use most effectively. Figure 1-4 shows the number of different software packages and languages that are used or desired by the User Community by software package category.

SOFTWARE PACKAGE CATEGORY	NUMBER OF UNIQUE PACKAGES/LANGUAGES
DATABASE MANAGEMENT PACKAGES	36
ENGINEERING PACKAGES	15
GRAPHICS PACKAGES	33
PROGRAMMING LANGUAGES	15
PROJECT MANAGEMENT PACKAGES	19
SCIENTIFIC SOFTWARE LIBRARIES AND CODES	14
STATISTICAL PACKAGES	14
SIMULATION/MODELING PACKAGES	12
P.C. COMMUNICATIONS PACKAGES	22
WORD PROCESSING PACKAGES	33
CAD/CAM and FACTORY AUTOMATION PACKAGES	7
TOTAL NUMBER OF UNIQUE SOFTWARE CAPABILITIES	220

Figure 1-4 Unique Packages/Languages By Software Package Category

Using an average cost of $100,000 for a mainframe software package and assuming the need for twenty such packages will exist, a $2,000,000 mainframe software acquisition cost was estimated. Assuming a 10% software maintenance/upgrade annual cost would be reasonable, coupled with immediate acquisition of about ten packages, an expected software maintenance cost of $2,000,000 would be reasonable over the ten-year life cycle. Thus, a mainframe software expenditure of about $4,000,000 is anticipated over the life cycle for the central computing facility mainframe.

Using an average cost of $50,000 for a minicomputer software package, combined with a need for ten software packages, yields a $500,000 software acquisition cost estimate for a minicomputer. A 10% software maintenance fee, coupled with the assumption that all the software is acquired immediately with the hardware, yields an additional annual cost of $50,000 or a life cycle cost addition of $500,000. Thus, a minicomputer software expenditure of about $1,000,000 per minicomputer is anticipated over a ten-year life cycle.

Furthermore, assuming that it is reasonable to expect software acquisition expenditures to be about $15,000 for a sophisticated super-microcomputer and about $5,000 for a personal microcomputer; along with 10% software maintenance fee, then, the life cycle software acquisition and maintenance costs are $30,000 for a super-microcomputer and $10,000 for a microcomputer. These figures were used to develop software acquisition and maintenance costs in accordance with the current hardware acquisition plans. Figure 1-5 shows the software package acquisition and maintenance cost estimates for various levels of computers.

EQUIPMENT	FY86-94 ESTIMATED QUANTITY	ESTIMATED SOFTWARE COST	LIKELY MAXIMUM QUANTITY	LIKELY MAXIMUM SOFTWARE COSTS
MAINFRAMES	1	$ 4,000,000	1	$ 4,000,000
MINICOMPUTERS	72	72,000,000	144	144,000,000
MICROCOMPUTERS (SUPER)	450	13,500,000	600	18,000,000
MICROCOMPUTERS (PC)	482	4,820,000	2,000	20,000,000
		$ 94,320,000		$ 186,000,000

Figure 1-5 Software Package Acquisition and Maintenance Cost Estimates

TELECOMMUNICATIONS REQUIREMENTS

The data collected regarding telecommunications requirements was very sparse. The data showed that currently there are only 184 Modems, 12 Multiplexors, 5 Communications Processors, and 235 Communications lines/circuits. The anticipated demand for the next nine years was expressed on the Organizational Level Questionnaire for only 126 Modems, 1 Multiplexor, 11 Communication Processors and 168 Communications lines/circuits. This means that over the long-term there would exist only 310 modems, 13 multiplexors, 16 Communications Processors, and 403 Communications lines/circuits. This data appears to be on the low side, as far as the quantities are concerned.

If the actual number of S&E Computer Users grows to between 3500 and 4000, and each User has either a microcomputer or a terminal, it is likely that the information provided was not very well thought out; or everyone thought that the local area networking of most of the microcomputers and terminals would cut down on the number of telecommunications devices like modems, multiplexors, communications processors, etc. In any case, a more thorough analysis cannot be performed due to lack of reasonable data. Although, it can be independently estimated, that a reasonable number of these communications devices would be: 600 Modems, 50 to 75 Multiplexors, 25 Communications Processors and 700 Communications lines/circuits. These quantities, of course, can only be determined during a detailed systems design exercise.

The Users want to be able to sit down at their own terminal or microcomputer and access any other computer at MICOM through a network, or access other computers through network gateways. This is the real telecommunications requirement that needs to be satisfied for both interactive

and batch processing and data transfers (both small and large files). The network system(s) must handle both the unclassified and classified requirements, both on and off the base.

The telecommunications requirements exist for communications capbilities within organizations and between organizations; between different floors of a building and between buildings, both on and off the Arsenal. A well-designed Integrated Data Communications Utility Network will be able to handle the current and future requirements.

ACCESS REQUIREMENTS

Terminal, micro and minicomputer access to the S&E Central Computing facility is required in both a dedicated and dial-up mode. The line-speed access requirements will remain at 300 through 9600 BAUD for most Users. Some 50.2KB circuits will be required for access to the Army Supercomputer Network in the near future. The potential exists for some higher line speeds (possibly 19.2KB), if CAD/CAM is supported on the mainframe computer. The potential also exists for some computer-to-computer interfaces via hyper-channels between the VAX and CDC machines. Remote Job Entry service at 9600 and maybe 19200 BAUD might be a good incentive for S&E Users to use the CDC machines for larger problems with large printout requirements.

The most important access requirement is that the access to the S&E Center be provided at a lower cost than it is now; otherwise, the User Community will continue to seek, what is in their opinion, more economical alternatives for satisfying their ADP needs.

ANALYST SUPPORT REQUIREMENTS

The User Community wants turnkey analyst support services for hardware, software and telecommunications needs across microcomputers, minicomputers, mainframes and supercomputers. They want the services to be performed in industry timeframes, not government timeframes. When they have needs, they want them satisfied NOW, not six months from NOW. The Users want analyst support in their application areas. The support must cover analysis of the requirement, selection of hardware and software, design of the system, programming, implementation, documentation and on-going support of the application. Analyst support is needed for both short-term and long-term assignments. The scope of MISD provided analyst support services must dramatically increase in order to satisfy the User's needs.

To adequately meet the needs for analyst support services, the size of the MISD S&E Support Staff must increase by about 15 to 20 people more than it is now. And, potentially, the total staff required might reach about 80 over the long-term, if adequate support is to be provided to the User Community. In addition, the staff must develop and maintain expertise in state-of-the-art hardware, software, telecommunications, and scientific and engineering technology.

CONTRACTOR SUPPORT REQUIREMENTS

The data collected on the Organizational Level Questionnaire regarding contractor support was very poor and very misleading. Many respondents did not know or were unwilling to research the information requested, or, refused to supply any reasonably accurate information concerning contractor support in the ADP and S&E Computing areas. It was quite obvious, that the issue of contractor support is a rather politically-sensitive subject. Nevertheless, according to the data provided, the number of contractor support personnel will double over the long-term. Approximately 50% of the contractor personnel will be using computers. Of those about 80% will perform work directly related to Scientific and Engineering Computing.

The data collected indicated that slightly over four hundred contractor personnel were currently being used across the twenty-five organizations interviewed. The data showed that 62% of the contractors used computers and 44% used computers for S&E-related work. Follow-up data collection efforts with MICOM personnel, at the Application and User Levels, indicated that there might be well over two thousand contractor personnel who work with computers for organizations on the Arsenal; and, that there may be well over one thousand of them who use computers for S&E Applications. In any case, there may be a one-to-one ratio of government personnel to contractor personnel, when it comes to estimating the total size of the S&E Computing User Community. Thus, the total size of the S&E Computing User Community is currently estimated to be between 2000 and 3500 (including contracor personnel). Little more can be said regarding this type of contractor support, except that the Command utilizes contractor support to perform

Scientific and Engineering Computing work and such support will be required in the future.

On the other hand, to execute all phases of the proposed Master Plan and Implementation Strategy, IMD will need to acquire significant contractor support services. If IMD is to provide TOTAL SUPPORT for the S&E User Community on a TURNKEY BASIS, up to about seventy-three contractor personnel will be required. Figure 1-6 depicts the IMD, CPO and Contractor Support Staffing requirements for implementation of the total concept proposed in this study as the solution to the S&E ADP Computing Requirements.

Minimally, to run the new S&E Central Computing Facility, about 20 Contractor personnel are required to provide basic system support and to begin to provide new software package support to the S&E Users. Additional contractor-support requirements depend upon just how far IMD wishes to go in pursuit of satisfying the needs of the S&E User Community. The higher the degree and quality of support that is to be provided, the greater the impact upon both the internal staffing requirements for IMD and the need for additional Contractor Support.

ISI recommends that IMD determine the level of support to be initially provided, obtain the necessary Contractor Support through a long-term delivery-order contract, and, begin the planning tasks for the S&E Computer Center replacement, as soon as possible.

	IMD PERSONNEL	CPO PERSONNEL	CONTRACTOR PERSONNEL
PHASE I			
a. Central Facility Support			11
b. End-User Equipment Support	3		8
c. Public Relations Campaign	3		
d. Turnkey Software Support Services	4		8
e. Turnkey Local Demo and Training Facility	4	2	10-15
f. Augment IMD S&E Staff	10		
g. Turnkey Overflow Analysis and Programming			10
h. S&E Center Management Tools			3
	24	2	50-55
PHASE II			
a. Develop Telecommunications Expertise	5		
b. Promotion of Distributed System Concept	.25		
c. Detailed Study and System Design			5
(1) Implementation	TBD		TBD
(2) Operations, Maintenance and Support	TBD	1	TBD
	5.25	1	5
PHASE III			
a. Develop Supercomputer Expertise	2-4		
b. Develop Scalar to Vector Conversion Techniques	(a.)		
c. Contractor Support for Supercomputers			5
d. Requirements Analysis for Supercomputers	(a.)+(c.)		(a.)+(c.)
Obtain, Operate, Maintain, Support a Supercomputer	TBD	1	TBD
	2-4	1	5
PHASE IV			
a. New Technology Assessment	2		
b. Long Range Strategic Planning	3		
c. Ad hoc Contractor Support			4
d. Involve Key User Groups in Planning	(a.)+(b.)+(c.)	1	
	5	1	4
PHASE V			
a. Turnkey Support for Unique Distributed Requirements	4	—	4
	4		4
TOTAL STAFF REQUIREMENTS:	40.25-42.25	5	68-73

Figure 1-6 Total Turnkey Support Staffing Requirements

TRAINING REQUIREMENTS

The data collected on the Organizational Level Questionnaire and through the face-to-face interview process, showed that training is the second biggest problem that MICOM has, next to the Computer hardware availability problem. A substantial computer literacy problem exists at MICOM that can only be rectified by a comprehensive training program directed at all levels of management, all levels of technical staff, and, all levels of support staff. The training issue can be addressed and resolved, if a local Demonstration and Training Facility is developed and more extensive use of PLATO for delivery of computer-based training is provided throughout the Command, in the form of a training network that is adequately supported by technical expertise.

The magnitude of the training requirement is vast. Over the next ten years, at least half to three-quarters of the 9,000 civilian and military personnel on the Arsenal should have extensive ADP training provided to them. If each individual receives a beginner, intermediate and advanced class across just five subject matter areas, that yields fifteen training units per student. At a student population of 4,500 or 6,750, the number of required training units are 67,500 and 101,250, respectively. If the number of subject matter areas doubles to ten, then the number of required training units double to 135,000 and 202,500, respectively. Clearly, the potential demand for training exists at sufficient magnitude to justify the establishment of a permanently-staffed training support center to handle most of the routine ADP training requirements.

The most important requirement regarding training, is that it must be provided locally and at a reasonable cost. Mid-level management is reluctant to spend a lot of money on training and the travel associated with sending

people to classes in other cities. Mid-level management is also reluctant to permit their staff to take the time away from their work to attend training classes. Thus, a network of training terminals widely distributed throughout the Command might be an incentive for the Command to take full advantage of computer-based training. A detailed study should be performed to further investigate the training issue and develop a comprehensive training approach.

The training requirements were difficult to analyze because the training question on the Organizational Level Questionnaire was designed to be an open-ended response question; and, many respondents provided information in a different fashion. In some cases, no information was provided or it was indicated that all training would be done in-house or via On-The-Job Training (OJT). To facilitate some meaningful quantification, the data was analyzed and grouped into twenty different general categories. The actual data provided was aggregated into these categories. Additional estimates of training requirements were made based upon knowledge developed about each sub-organizational element and their ADP equipment needs and software capability needs. Figure 1-7 shows the tabulated and estimated training requirements by category. It shows the number of people that need training by category, but doesn't provide the number of training units required by software package or by specific machine, etc. A separate study should be conducted to determine the actual magnitude of the training requirements by subject area, software package, hardware, etc. The development of a master plan for addressing the overall training issue was not within the scope of this contract. Additional research work will be required to solve the training problem.

	TABULATED # OF INDIVIDUALS			ADDITIONAL ESTIMATES # INDIVIDUALS		
	CURRENT	NEAR TERM	LONG TERM	CURRENT	NEAR TERM	LONG TERM
Database Management Systems	240	585	194	387	247	770
Science & Engineering Packages	199	229	208	54	35	65
Graphics	59	63	60	137	137	148
Programming Languages	1324	1541	1343	287	204	538
Project Management Packages	134	165	148	141	137	204
Scientific Software Libraries & Codes	0	0	0	59	63	62
Statistical & Financial Packages	36	38	36	8	7	9
Simulation/Modeling	45	54	42	60	62	135
Personal Computer Communications	14	12	11	54	84	84
Word Processing Packages	138	127	86	38	66	121
CAD/CAM & Factory Automation	98	111	100	0	0	30
Operating Systems, Maintenance, Troubleshooting & Systems Integration	203	244	204	225	234	389
Telecommunications & Networking	150	190	206	246	267	341
Microcomputer Training, Terminal Training, Minicomputer Training, Accessing Mainframe, & JCL	173	310	176	260	235	405
Spreadsheet	89	103	81	18	21	66
Canned Software Application Packages (nonspecific S&E & Business)	1164	1304	1320	190	168	319
Tailored Software Application (S&E & Business)	1128	1276	1292	210	198	319
Math Analysis Techniques	59	62	67	17	22	22
Subject Matter	172	169	136	112	163	235
General ADP Orientation (for Users & Non-Users)	198	206	208	222	248	265
	5623	6789	5918	2725	2598	4527

Figure 1-7 Estimates of the Number of Individuals Needing Training

1.7 Analysis of the System Alternatives

There are basically two management alternatives that exist regarding the replacement of the S&E Computing Center mainframes. The first alternative is to do nothing and keep the S&E Center as it exists. The second alternative is to take _immediate_ action to pursue the replacement of the existing mainframes, improve the level of support to the S&E Community, and develop a long-range solution to the computing needs of the Users. The relative advantages and disadvantages of each alternative are discussed below. They are followed by a management decision recommendation and then by an analysis of the system alternatives. Then, the general direction to pursue is recommended.

Alternative A - Do nothing now. Wait Until later.

Advantages:

o   No effort is required to do anything now.

o   No changes are required.

o   Everything remains status quo.

o   Resources can be directed to other endeavors.

o   No large cash outlay is required to purchase replacement hardware.

o   No justification is required.

Disadvantages:

o   Users will continue to migrate workload away from the S&E Center, either to other large computer centers or onto their own overworked minicomputers and microcomputers.

o   Decreasing revenues, rising maintenance costs and rising operations costs will drive up already high rates for service.

This will accelerate the process of workload migration away from the center, even more.

o   The S&E Computing Facility will be forced out of business in twelve to sixteen months.

o   This action will destroy what little credibility IMD has with the S&E Community.

o   The morale of the S&E Community, who use the S&E Center, will be adversely affected, because they now have a faint glimmer of hope that the hardware will be replaced and the level of service and support will improve.

o   Economically speaking, the maintenance costs alone for the old hardware is sufficiently high to create a payback period of about three to five years in favor of machine replacement NOW.

o   Over time, the old equipment, which is now over two generations old, will become extremely difficult to maintain, and will have to be replaced eventually due to obsolescence.

o   The Users frequently voiced requirement for virtual memory capability will not be met.

o   The technical requirements of the S&E Users are not met by this alternative.

o   This avenue is not a cost-effective alternative, and is a poor management decision.

Alternative B - Take immediate action to replace the existing mainframes and develop a long-term plan geared to meeting the needs of the S&E Community well into the late 1990's.

Advantages:

o   The Users will be happy. Morale will be greatly improved.

o   Virtual memory and larger central memory will be available to run large problems.

o   The replacement system will be state-of-the-art.

o   Productivity will increase dramatically, if all our recommendations are accepted.

o   This avenue is cost-effective and forward-looking.

o   Overall MICOM ADP Hardware Procurement cost can be controlled and some future costs can be avoided.

o   A variety of software packages, that won't run on the old machines due to central memory limitations, can be acquired for usage on the replacement machines. Software packages can cut down dramatically the cost of creating new applications, and reduce the application maintenance costs over the life cycle of the application. The net result is future cost avoidance for application development. Modern software packages are easy to use and may be used by non-programmers, thus creating individual productivity improvement opportunities. Scientists and engineers can do things on the computer without needing a programmer to do everything for them.

o   The User requirements for Database Management Systems, Graphics Capabilities, Engineering Support Packages, Project Management Packages, Scientific Software Libraries, Simulation/Modeling Languages, Statistical Analysis Packages, Word Processing Software, Upload/Download capabilities, CAD/CAM and Factory Automation Packages can be supported on the replacement hardware, if decision to support these areas are made by IMD management.

o   The perceived usefulness of the S&E Computing Center will migrate from a not very useful status to a cannot live without status. Of course, this will not happen overnight. But, if properly managed, the new concept of support can yield a cost competitive alternative to S&E Users who require the capability to run large problems cost-effectively.

o   As Users are attracted to the system, the rates must be dropped proportionately. All Users will benefit from lower rates.

o   IMD will gain credibility for doing something for the S&E Community.

o   Some of the bitter feelings that permeate throughout MICOM may pass away, over time.

o   Organizations may learn the lesson that cooperation is the only way to insure overall MISSION accomplishment by all organizations.

o   All the technical reasons associated with this course of action are quite sound and reasonable.

Disadvantages:

o   Doing something requires a commitment of resources, that may not be available for the amount of time required.

o   Appropriate levels of funding may not be available quite when they are needed.

o   MISD needs additional staff now to adequately begin to support the needs of the S&E Community. Over the past ten years, the IMD S&E Support Staff has declined from over fifty to thirty-five, while the number of S&E Computing Users has probably more

than doubled. Furthermore, the number of Users may double or triple over the next ten years. IMD may not be able to get the additional staff they need in order to develop the kind of support capability that the S&E Community needs.

o IMD will have to augment its capability with contractor support in order to accomplish the support task requirements, and may not have the funds available to do so.

o Some S&E groups of Users may continue to do their own thing regardless of the good intentions of IMD in developing cost-effective solutions to computing requirements.

o Unless cooperation across MICOM organizations is achieved as a top management goal, this sound alternative will not work in the long run. Organizations will be skeptical, until they see something happening that benefits them directly. Human nature dotes on the past rather than concentrating on the future. The required change in attitudes on the Arsenal, from negative to positive thinking, will take some time, but it is possible.

o The level of success that can be achieved is limited only by the level of cooperation that can be obtained from organizations and people on the Arsenal.

o The MICOM Commander may not be that supportive of the concept presented in this document as a solution to the S&E Computing needs. He may have his own idea of how he wants things done.

Therefore, we recommend Alternative B as the appropriate course of action to take by IMD management. After this decision point is reached, there are basically three conceptual alternatives for system implementation. They are Total Centralization, Total Decentralization and a Distributed Hierachical

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Data Processing System approach.

A brief description of each conceptual alternative along with the identification of some of the relative advantages and disadvantages of each alternative are discussed below.

Alternative A - Total Centralization

Under the scenario of Total Centralization, all of the major computing power resides in one central location. The machines are centrally acquired, maintained and operated. Everybody is forced to use the central facility with no exceptions. Users are provided with graphics terminals, printers, plotters and other peripherals as required. No organization would have their own computers. The central computing facility would provide a variety of supercomputers, mainframes and minicomputers to satisfy every need. The supercomputers and mainframes would be used to handle the majority of the workload. The minicomputers would be used for so called "unique" requirements. All significant computer resources would be shared by everyone. As the workload continues to increase, more supercomputers, mainframes and minicomputers would be added to handle expected growth. The center would consist of the largest/most powerful computers from each vendor. For example, one could imagine a large multi-vendor center containing CRAY, CDC, UNIVAC, IBM, DEC, Hewlett Packard, Gould, Prime, etc., equipment. Although, it would make more sense to limit the number of different vendor types to five or so. To be successful, this operation would have to run like a commercial timesharing company. System availability and response time would have to be top management priority.

Advantages:

o   Physical number of "computer centers" is reduced, along with the number of large and mid-sized computers that will exist.

o   Space is saved.

o   Power consumption is cut.

o   ADPE Expenditures are minimized through machine consolidations, over the long-run.

o   Hardware is centrally maintained and operated.

o   Significant savings could be realized on maintenance costs.

o   Significant savings could be achieved in the area of software package acquisition and maintenance costs.

o   The total computing resources are shared to the maximum extent possible.

o   The concept facilitates TOTAL ADP Resource Management.

o   The concept is cost-effective.

Disadvantages:

o   *Resistance from the User Community would be high, because people feel that they have to have "control" over their own machine.*

o   Total management of the S&E Workload might be impossible or very difficult to accomplish.

o   IMD staff would have to increase substantially to handle such a formidable task.

o   The current procurement process doesn't provide too much assistance to the process of implementing this concept.

o   Funding this type of operation would probably require line item funding rather than AIF funding to make the concept work.

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o The concept is not quite what AMC had in mind when the
   "Blueprint for the 80's" plan was developed.

o The funding level for such an ambitious undertaking would have
   to go to DA and GSA for approval. The approval process alone
   could take years, followed by additional years to procure the
   system. In the meantime, things would continue the way they are
   now, which is not good.

Alternative B - Total Decentralization

Under the scenario of Total Decentralization, the need for a central
computing facility vanishes, along with the need for the people to run it,
along with the people to support the Users that are associated with the
central facility. Major computing power would be freely distributed to all
organizations who desired it. The organizations would then be responsible for
keeping the systems up and running, efficiently and effectively. They would
also be responsible for supporting their own User groups. IMD would then just
be providing hardware acquisition services to the S&E Community. Requirements
for computer time above existing machine capabilities could always be acquired
from commercial computing services at a premium cost.

Advantages:

o The Users would be happy, they have always wanted something to
   "control".

o All the computing power that the Users ever wanted would be
   placed in their own hands; whether or not it was efficiently and
   effectively used simply would not matter anymore.

o   The Users could learn first-hand what it takes to run larger
     computing centers.

o   The independent computing centers could be available as a
     function of User needs, i.e., on odd hours, weekends, holidays,
     etc.

o   IMD wouldn't have to worry about S&E User complaints anymore,
     because the Users would be on their own.

Disadvantages:

o   The User Community really is not ready for this approach yet.

o   This concept is not cost-effective.

o   Excessive power and space is consumed.

o   Central sharing of ADP resources does not exist.

o   The level of support across the various computing centers
     probably will not be consistent and not of a high quality.

o   Overall maintenance costs are higher due to the greater number
     of machines.

o   Overall software costs are higher as the number of independent
     computer facilities increases, due to replication of software
     license costs.

o   Overall hardware acquisition costs are not minimized.

o   Overall manpower support expenditures will be higher due to the
     lack of sharing of these resources across the command.

o   This concept is not supportive of the Army Industrial Fund
     method of operation. IMD, without the benefits derived from
     computer timesharing revenue, probably could not survive just on
     people-time revenue alone.

Alternative C – Distributed Hierarchical Data Processing System

The Distributed Hierarchical Data Processing System approach recognizes the need for both centralized and decentralized data processing capabilities to be made readily available to the S&E User Community. Under this scenario, the need for a controlled mix of supercomputers, mainframes, minicomputers and microcomputers is recognized as a feasible way of handling the TOTAL MICOM S&E Computing Requirements for the next ten years. Also, the need for an Integrated Data Communication Utility Network, to provide high-speed data transmission services between a variety of broadband high-speed Local Area Networks and to provide network gateways, is recognized. Centralized acquisition, maintenance, operation, and support of the entire spectrum of hardware, software, and telecommunications capabilities is recommended to insure that someone is responsible for the total system.

This approach attempts to take advantage of the benefits of both the centralized and decentralized processing concepts. It anticipates the technological advancements in the availability of raw computing power and the delivery of that power to the End-Users, in a cost-effective and cost-efficient manner.

Advantages:

o   The concept can be used to meet the TOTAL MICOM S&E Requirements over the next ten to fifteen years in a cost-effective, cost-efficient and forward-looking manner.

o   The number of "computer centers" could be minimized.

o   Total system hardware acquisition costs could be minimized.

o   Total system maintenance costs could be minimized.

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o   Total software package acquisition and maintenance costs could be minimized.

o   Total system operations costs could be minimized.

o   The number of different vendors providing the hardware and software, which make up the system, could be minimized and the system components could become somewhat standardized. This would contribute to cost savings and future cost avoidance.

o   Training costs over the system life cycle could be minimized and controlled.

o   Centralized support of the TOTAL SYSTEM could be developed, to support the hardware, software and telecommunications components of the system down through the End-User, on a turnkey basis.

o   The benefits of both centralized and decentralized processing can be shared by both Management and the End-Users alike.

o   The system could be implemented in a phased approach to minimize impact on the End-Users daily operations.

o   This approach is sound from a management perspective, technical perspective, cost perspective and End-User environment perspective. It is also politically viable.

o   This approach may get the most support from the S&E User Community.

o   This approach is the path of least resistance, all things considered.

o   The highest degree of individual productivity improvements could be achieved under this concept.

o   The TOTAL MICOM S&E Workload would, over time, migrate to the most appropriate levels of hardware.

o The amount of time that people spend waiting for access to ADP equipment and waiting for jobs to run on the computer would be minimized, if a properly designed Distributed Hierarchical Data Processing System were made available to the Users, at a reasonable cost.

o Access to computers is greatly improved through the availability of more powerful computers and the networking of them will provide ease of access.

o The concept provides a method for developing a standard method of operation and support for hardware, software and telecommunications requirements for a majority of the Scientific and Engineering Computing Requirements.

Disadvantages:

o Further research work is required to develop an initial detailed systems design and to develop an initial networking plan.

o A long-range hardware distribution plan must be developed along with appropriate contingency planning, to handle the evolution of the system.

o A distribution-control strategy for the number of supercomputers, mainframes, minicomputers and microcomputers must be determined, and adhered to, in order to prevent over-centralization or over-decentralization. This overall control strategy is likely to make Users, who want to "do their own thing", very unhappy.

o IMD will need additional staff resources and contractor support to undertake this effort.

o Unless the system is procured through a "Turnkey" contractor,

the system acquisition could turn out to be a procurement nightmare. Support of the procurement concept suggested here must be accepted by the Commanding General and the Chief of Procurement in the interest of "total system" life cycle cost minimization.

o A high degree of top management cooperation across organizations is required to make the whole concept work.

o The system will have to be acquired in pieces to facilitate the current procurement procedures.

The Recommended Approach:

The previous discussion of the conceptual system implementation alternatives was geared towards the concerns of management. It was intermixed with the concerns of the User Community and issues regarding the bureaucratic nature of the rules, regulations and politics of the Command. The determination of the recommended direction to pursue acknowledged the existence of these items. These items weighed quite heavily in the final analysis.

The concept of Total Centralization ranks as the most cost-effective approach, but it is the least attractive alternative from a political viewpoint. The Users feel that this approach never has worked in the past and probably would not work in the future. Futhermore, the User Community would not support this concept. The Total Decentralization Concept ranks as the least cost-effective approach, but is the most popular approach voiced by the User Community. The concept of having a Distributed Hierarchical Data Processing System ranks as a mid-road cost-effective approach, that is politically acceptable; and, it would be supported by the User Community.

ISI's recommendation is that the Command should pursue the concept of implementing a Distributed Hierarchical Data Processing System to meet the needs of the S&E User Community for the next ten to fifteen years. The system should be design and implemented to meet the TOTAL S&E REQUIREMEMTS not just selected, easy to satisfy, requirements. This recommendation is technically feasible and can be accomplished in a reasonably cost-effective, cost-efficient and forward-looking manner. Section 1.9 of this document provides an outline of the multi-phased Master Plan and Implementation Strategy for satisfying the TOTAL S&E REQUIREMENTS.

1.8 Summary of the Recommendations

The TOTAL Scientific and Engineering Computing Requirements over the next ten years can best be met by a Distributed Hierarchical Data Processing System. The system must be composed of an appropriate mix of supercomputer, mainframe, minicomputer and microprocessor computing power to handle the total workload generated by somewhere between 3500 to 4000 S&E Computer Users. The hardware must support quite a variety of software packages across the levels of hardware (meaning that software packages that run on a micro, mini, mainframe and supercomputer are of great interest to the User Community). The computers and peripheral devices, like terminals, printers, plotters, etc., must be interconnected by high-speed local area networks. Likewise, the local area networks must be interconnected by network gateways to other local area networks and potentially to other broadband networks. The total system must be procured, installed, operated, maintained, and supported on a TURNKEY BASIS. The objective of the system must be to satisfy the TOTAL S&E Requirements, or as many of them as technically possible. The system must be impartially designed to satisfy the technical computing needs of the Scientific and Engineering End-Users and not the needs of the political system.

MISD has the responsibility to accomplish this project and provide the level of service required by the S&E Community, as part of its MISSION. A multi-phased approach is recommended in Section 1.9, as a roadmap to MISSION ACCOMPLISHMENT. The following general and specific recommendations are provided as guidance:

o   Expand and improve the areas of service provided in terms of

hardware, software, telecommunications, consulting, training and End-User services.

o Explore, research, analyze, acquire, install, test, demonstrate, market and support a wide variety of state-of-the-art software packages/languages in the areas of Database Management, Engineering Packages (Aerospace, Electrical, Chemical, Civil, Industrial, Mechanical, Nuclear and Structural), Graphics, Programming Languages, Scientific Software Libraries and Codes, Simulation/Modeling, Statistical Analysis, Word Processing and Computer Assisted Design, Engineering and Manufacturing.

o Develop more expertise in End-User Application areas.

o Develop support capabilities across levels of hardware and across various vendor's machines that are used on the Arsenal.

o Develop permanent demo/training facilities (possibly in conjunction with the Career Development Center) to demonstrate new hardware/software capabilities and to facilitate local training programs. The savings in travel alone could pay for this facility.

o Develop and conduct "customized" training classes (possibly in conjunction with the Career Development Center) for hardware/software User development. Provide beginner through advanced techniques training seminars to facilitate the development of the End-User's skill level.

o Develop a new S&E User Manual with major emphasis on new software capabilities and service provided.

o Develop brochures and handouts, mailing campaign, newsletter, User conference and club/committees to encourage User and

Organizational participation in the evolution of the S&E Computing Environment.

o Continuously analyze and survey the User's Requirements and monitor evolution of the system and gauge how well the system is meeting the User's needs.

o Provide more ad-hoc analysis and programming support to the End-Users directly.

o Become a provider of turnkey solutions to User's ADP Requirements, in terms of hardware, software, telecommunications, and networking support.

o Provide Complete TURNKEY services.

o Replace the existing S&E Center hardware as an interim solution to the current hardware problems.

o A detailed study of the telecommunications requirements for the S&E Network should begin as soon as possible with mandatory cooperation being required from all organizations by direction from the Commander.

o Likewise, a detailed analysis of the current workload across all mainframes and minis should be conducted on an annual basis to facilitate design of the overall Distributed Hierarchical Data Processing System for S&E requirements. All organizations should be required to "turn-on" their computer's accounting system to facilitate this in-depth analysis.

o Hire a contractor to design, acquire, install, test, operate, maintain, and support the Distributed Hierarchical Data Processing System for the S&E Community on a TURNKEY BASIS.

o   Follow the Master Plan and Implementation Strategy outlined in Section 1.9 of this document.

o   Make it widely known that IMD is aware of the ADP problems confronting the S&E Community, and is aggressively pursuing a l ng-term plan aimed at solving the existing problems. The User Community also must be notified that IMD is trying to avoid future problems and needs the upmost cooperation from the S&E Community to achieve that objective.

o   Actively solicit the support of the Commander, the Comptroller, the Chief of Procurement and the Directors of all organizations who do any S&E work; for without this total support and total cooperation the system will not evolve as it was conceived.

These activities will provide the basis for development of a system to satisfy the TOTAL S&E Computing Requirements in a cost-effective and forward-looking manner.

The design of the overall system is critical to the long-term success of the system and its acceptance by the User Community. The distribution and control of significant ADP resources will be the most critical issues. Some decisions have to be made and some policy has to be formulated to facilitate the management of the system to be created. In the interest of overall hardware acquisition costs, software costs, maintenance and operations costs, it is recommended that the system be composed mainly of supercomputers, mainframes and micros. This will minimize the number of independent computer centers. The supercomputers and mainframes can be used to handle the real work that needs to be done and the micros can be used effectively to give the End-Users some individual computing power. The

minicomputers should be used only for special laboratory and test-cell applications like real-time simulation or real-time data collection or automated test equipment or process control; and, the number of them should be minimized and sharing of the minicomputers should be encouraged.

The Distributed Hierarchical Data Processing System may end-up being composed of one supercomputer (100 MIPS or above), two large mainframes (30-60 MIPS class), about ten to twelve medium mainframes (5-20 MIPS class), and about 2000 microcomputers. These would be networked to approximately fifty minicomputers (3-10 MIP class) and up to 1500 terminals. A thorough cost analysis of this design approach, which is beyond the scope of this contract, would demonstrate the merits of this suggested approach. The system design would attempt to incorporate as much of the existing hardware as possible to protect MICOM's previous capital investments in computers.

During the 1970's, MICOM spent over $13,000,000 on ADP Acquisitions. During 1980 through 1985, MICOM spent over $16,500,000 on ADP Acquisitions. Along with these figures, MICOM spent over $7,000,000 on ADP leasing. Now with the advent of the Intel 310 and WYSE PC buy, and the forthcoming minicomputer buy, MICOM will spend somewhere between $50,000,000 to $100,000,000 on what amounts to be a bunch of microcomputers and small minicomputers. Additional hardware already purchased, but not recorded yet in the DARCOM ADP Inventory System, may amount to an additional $25,000,000. If half of these funds were directed towards the more powerful end of the ADP Equipment Spectrum (i.e., supercomputers and mainframes), a total distributed system would already exist that would be meeting the User's Total Requirements.

The basic problem is that the procurement process treats ADP equipment acquisition in the same fashion that it treats a major weapons system acquisition. The acquisition approval process encourages acquisition of less expensive ADP equipment and makes cost-efficiency impossible. For example, it is much easier to procure ten VAX machines for $300,000 each or $3,000,000, than it is to procure a single mainframe machine for about the same price. Thus, the road to cost-efficient satisfaction of the TOTAL S&E Computing Requirements will not be an easy one, but it must be wholeheartedly pursued by the Command.

1.9 Summary of The Master Plan and Implementation Strategy

In order to satisfy the needs of the MICOM Scientific and Engineering Community, IMD must substantially increase the variety of goods and services that it is willing to provide and to support. The S&E Community is looking for IMD to provide TOTAL TURNKEY SUPPORT services. Our recommendation is that IMD, over time, develop the capability to provide TOTAL SUPPORT for the S&E Community to cover hardware, software, telecommunications, training and End-User support, across the mix of vendor hardware and software capabilities that are used/required by the S&E Community. IMD should take immediate action to finalize the details of some of the specific recommendations provided in this document, then execute some of the recommendations to reestablish some credibility with the S&E Users. Then, the remainder of the Master Plan and Implementation Strategy should be presented to the S&E Community, revised as appropriate, then adopted and executed as soon as possible.

The computing needs of the S&E Community can be best satisfied by a controlled Multi-Level Distributed Data Processing and Data Communications Network interconnecting various levels of computing power (i.e., supercomputer, mainframe, minicomputer and microprocessor). Such a system can be conceived, designed, developed, implemented, integrated, operated and maintained to support the TOTAL MICOM S&E Computing Requirements into the next decade, if the USERS and IMD are willing to work together to make it happen.

PHASE I

The following recommendations are presented as action items to pursue immediately to remedy existing problems with the S&E Computing Facility and the current S&E Computing environment at MICOM, and to improve and expand

the areas of service that IMD provides. The following action items constitute the first phase of the Master Plan and Implementation Strategy.

a. The existing mainframes and selected peripherals must be replaced IMMEDIATELY. Develop a contract vehicle to accomplish this as soon as possible, along with installation, maintenance and analyst services.

b. Develop a contract vehicle to procure on a task order basis the following types of End-User equipment: portable and CRT terminals, remote terminal printers, graphics terminals, plotters, CAD Workstations, and communications gear like modems, multiplexors, concentrators, local area network interface processors, and cable; along with manpower support for equipment installation, training, maintenance, User support and consulting services for Users who need assistance in determining their equipment needs. Utilize this vehicle as a means of helping to standardize equipment out in the field by facilitating procurement.

c. Initiate a public relations campaign to inform the User Community about the new level of services to be offered by IMD. Develop a brochure, handout, and a new S&E Center User Manual to demonstrate new capabilities.

d. Develop a contract vehicle to procure on a task order basis the following types of software support services on a turnkey basis: software studies, software acquisition, installation, testing, analysis, demonstration to the User Community, training, User support and consultation services in determining which software packages a User should use for their particular application and on which level and type of hardware their application should be executed on. Utilize this vehicle as a means of delivering software packages to the Users.

e. Work with the Career Development Center to establish a local

Demonstration and Training Facility with the types of equipment that will be supported as standard equipment. Connect these pieces of equipment to both the S&E and Business centers for demonstration purposes. Acquire sufficient quantities of equipment to facilitate training activities. Secure a contractor to provide turnkey training services. Develop "customized" training programs for the User Community.

f. Augment the current IMD S&E analysis and programming staff, if possible. Educate, train and develop these staff to assume expanded responsibilities in the software and application support areas.

g. Secure a task order contract to handle overflow analysis and programming support on an as-needed basis to augment IMD S&E programming staff capabilities. Utilize this vehicle to provide support in areas related to S&E that may have been overlooked in the past because of lack of interest on the part of IMD S&E staff.

h. The IMD S&E Computer Center needs to develop some additional automated tools to be used in evaluating and managing the work being accomplished on the computers at the center. The existing summary reports are fine, but no extensive across-month and across-year profiles are available for analysis or for management presentation and review.

These activities will assist IMD in developing a foundation upon which to build a TOTAL TURNKEY SUPPORT capability. In addition, they provide the beginning of a process that will, over time, bring about a standard method of operation and support for the S&E Community. They will, if accepted by IMD Management and the Base Commander, translate into future cost savings and cost avoidance in real dollars spent, over the anticipated ten year life cycle.

PHASE II

The second phase of the recommended Master Plan and Implementation Strategy addresses the long-range telecommunications networking and distributed processing requirements for the MICOM S&E Community. In the long run, an Integrated Data Communications Utility Network will be required as an integration medium for all the Local Area Networks that various organizations are in the process of creating or have already created; and a Distributed Hierarchical Data Processing System will be required to handle the Totals S&E Computing Requirements. The following steps should be taken to accomplish Phase II.

a. Develop additional in-house telecommunications expertise. Consider establishing a division or branch to assume responsibility for the S&E Networking Requirements.

b. Formally notify the S&E Community about IMD intentions to design, develop, operate and maintain an S&E Telecommunications Network and a Distributed Data Processing System for S&E Computing needs. Solicit the support of all interested parties to insure success of the network.

c. Develop a contract vehicle to obtain the services of a turnkey telecommunications networking and systems integration contractor to further study, design and implement the system. The contractor who will:

(1) Perform a detailed study of the MICOM S&E Telecommunications Networking Requirements and determine the appropriate technical approach to satisfy those requirements from a networking point of view and a security point of view.

(2) Perform a general systems design for the S&E network architecture and the Distributed Hierarchical Data Processing System.

(3) Develop the detailed system specifications for the network and for the Distributed Data Processing system.

(4) Develop a comprehensive phased network and distributed system implementation plan and cost estimate.

(5) Implement the S&E Network and the distributed system.

(6) Operate, maintain, manage and support the S&E Network and the distributed system.

(7) Link-up the S&E Center with the Business Center via Networking.

These activities will solidly place IMD into the Data Communications and Distributed Data Processing business. IMD can then provide integrated telecommunications support services for the whole Arsenal and ensure total compatibility between the S&E and Business environments.

PHASE III

The third phase of the recommended Master Plan and Implementation Strategy will be to augment the S&E Center with a Hardware Vector Processing Capability. The following steps should be taken to accomplish Phase III.

a. Develop in-house expertise in supercomputer hardware and software techniques. Market this expertise and support the organizations who currently have a supercomputer applications or plan to migrate their applications to a supercomputer environment in the future.

b. Develop an in-house capability to convert standard scientific and engineering codes to vector codes. Become familiar with or even develop some vectorization codes. Market this capability. Prepare to get into the Supercompter business.

c. Acquire contractor support to augment the capabilities being developed in-house in the area of supercomputers.

d. Develop a contract vehicle to obtain, operate, maintain and support a Supercomputer for the MICOM S&E Community. The size and type of Supercomputer can be determined by a study conducted by the contractor acquired in item (c.) above and in-house staff who will then be intimately familiar with the Users requirements.

The aforementioned items will place IMD in the Supercomputer Business. They will afford IMD an opportunity to grow in size, as the demand upon IMD to provide supercomputer support increases proportionately to the increasing number of supercomputer Users. Recall that, based upon this survey's data tabulations, the anticipated number of supercomputer Users is expected to grow from a handfull to about 175 over the long-term. But, as the number and sophistication level of the S&E Computing Community expands, it can be expected that the number of 175 will represent the floor of the number of supercomputer Users, rather than the ceiling. Anticipation of the future requirements is the key to providing the S&E Community the services they need, before they even realize that they need them.

PHASE IV

The fourth phase of the recommended Master Plan and Implementation Strategy calls for IMD to actively pursue and seek out new technologies and to evaluate their usefulness to the Scientific and Engineering Community. As promising hardware, software, and telecommunications technologies emerge and mature, IMD should temporarilary access or acquire new technology, test and evaluate the capabilities, demonstrate the capabilities to the User community and market these capabilities to potential Users. Providing this type of

service to the Users in conjunction with the establishment of a local Technology Demonstration and Training Facility would permit thorough evaluation and benchmarking of potentially useful products before mass quantities are procured through normal channels. This type of interest in new technology, coupled with continuous long-term strategic planning, can insure that a state-of-the-art S&E Computing Environment is always available to the User Community. The following steps should be taken to accomplish the goals of Phase IV:

a. Designate some in-house individuals who will become actively involved in new technology assessment duties.

b. Designate some in-house resources to get involved in long-range strategic planning efforts.

c. Supplement these designated individuals with additional staff resources, if available. Also, acquire additional contractor support services as required, on an ad hoc basis, through a long-term delivery order contract.

d. Get key User groups involved in the long-range planning efforts, for their support of the whole concept is essential for success.

The resources identified above should serve as the IMD technical liaison to the User Community to both identify their needs and help find ways to satisfy their needs. These individuals should also conduct technical seminars concerning what IMD is doing for the S&E Users and what they plan to do in the future. These types of activities will help to re-establish the credibility that DMIS once had with the S&E User Community.

PHASE V

The fifth phase of the recommended Master Plan and Implementation

Strategy calls for IMD to become a provider of turnkey support for distributed systems. This business concept involves providing mainframes, minicomputers and microcomputers along with some support, for unique application areas that might not be totally supported by IMD due to its unique characteristics. IMD could provide as a service the requirements determination, develop the procurement package, conduct the evaluations and provide the turnkey solution to a User's special requirements. The hardware and software could be acquired, installed, tested, operated and maintained by IMD or IMD supplied resources. Interfacing/connection services for connecting this type of system to the MICOM S&E Network would be provided as standard operating procedure. The level of service could be adjusted to meet User requirements. In a similar fashion, hardware upgrades could also be performed as a service. This option, of course, depends upon IMD interest in providing this type of service.

Phase I, Phase II, and Phase III of the Master Plan and Implementation Strategy should be viewed as a mandatory course of action to satisfy the growing computing needs of the S&E Community over the next ten years. Phase IV should be viewed as a strongly recommended course of action to keep IMD abreast of technology advancements and to develop an active IMD participation in providing alternatives to satisfying User needs. Users might begin to look to IMD for solutions to their problems, instead of viewing IMD as being one of their problems. Phase V should be viewed as a nice to have service which would clearly show that IMD is willing to go out of its way to provide TOTAL SUPPORT to the S&E Community.

1.10 <u>Summary of Implementation Life Cycle Cost Estimates</u>

The actual life cycle costs for the total system can only be determined at the time of contract award, during the execution of the Master Plan and Implementation Strategy. Where possible, detail life cycle cost estimates were developed for parts of each major phase of the Master Plan. Where detailed estimates could not be developed due to lack of information, rough budgetary figures were provided; or, at least, the magnitude of the costs were estimated. Some detailed cost estimates for variations of the initial hardware replacement decision in Phase I were developed, due to the immediate critical nature of the problem at hand. More detailed cost estimates for the entire Distributed Hierarchical Data Processing System should be developed as part of the system design effort in Phase II. The estimated costs for each major item within each major phase are identified and discussed below.

PHASE I LIFE CYCLE COSTS

a. There are basically three feasible cost-effective alternatives for replacement of the existing CDC 6600 and CYBER 74 machines. The basic strategy is to utilize as much of the existing peripherals (disk, tape, printers, communication gear, etc.), as possible to minimize software conversion costs and retraining costs. This strategy reduces to replacing the existing mainframes with either a CDC CYBER 180/850, CYBER 180/860, or CYBER 180/990 configuration. All of these configurations meet the basic User Requirements for virtual memory and a faster CPU. Figures 1-8, 1-9, and 1-10 provide a detailed life cycle cost analysis for each alternative. The

analysis includes the outlay for initial hardware, likely system upgrades that anticipate future growth in system workload, and maintenance costs assuming a 5% escalation per year over the ten-year life cycle.

CYBER 180/850 HARDWARE CONFIGURATION
COST ANALYSIS

STARTUP COSTS:

PRODUCT	QTY	DESCRIPTION	TOTAL PRICE	MONTHLY TOTAL LEASE	TOTAL MAINT
180-850	1	CENTRAL PROC 16MB	$ 1,115,000	$ 46,170	$ 3,790
18551-16	1	MEMORY INCR. 16MB	200,000	11,100	600
18352-1	1	5 PP/12 CHAN. INCR	48,000	1,670	100
18352-2	1	5 PP INCREMENT	24,000	835	55
18002-1	1	SYS. CONSOLE NOS/BE	19,900	735	75
18002-2	1	SYSTEM CONSOLE	2,450	132	31
			$ 1,409,350	$ 60,642	$ 4,651

LIKELY UPGRADE COSTS: STAGE 1 completed in YR 1, STAGE 2 completed at end of YR 3

STAGE 1:   Provides a 28% cushion for workload growth over Cyber 180/850 configuration.

18559-1	1	CPU UPGRADE TO 860	$ 460,000	$ 14,430	$ 700
18551-32	1	MEMORY INCR. 32MB	400,000	22,200	1,200
			$ 860,000	$ 36,630	$ 1,900

STAGE 2:   Provides an additional 80% cushion for workload growth over single CPU configuration.

18557-2	1	SECOND CPU	$ 855,000	$ 31,530	$ 2,700
18553-2	1	CACHE MEM. INCR. 16KB	54,000	1,670	65
			$ 909,000	$ 33,200	$ 2,765

WITHOUT PRICE INCREASE TOTAL PURCHASE PRICE: $3,178,350
WITH PRICE INCREASE OF 10% FOR 2nd CPU UPGRADE: $3,269,250

LIFE CYCLE MAINTENANCE COST ESTIMATES ASSUMING 5% ESCALATION PER YEAR

YEAR	MONTHLY COST	ANNUAL COST
1	$ 4,651	$ 55,812
2	6,879	82,548
3	7,223	86,676
4	10,785	129,420
5	11,324	135,888
6	11,890	142,680
7	12,485	149,820
8	13,109	157,308
9	13,764	165,168
10	14,452	173,424
TOTAL		$ 1,278,744

Figure 1-8 Hardware Alternative #1

CYBER 180/860 HARDWARE CONFIGURATION
COST ANALYSIS

STARTUP COSTS:

PRODUCT	QTY	DESCRIPTION	TOTAL PRICE	MONTHLY TOTAL LEASE	TOTAL MAINT
180-860	1	CENTRAL PROC 16MB	$ 1,575,000	$ 60,600	$ 4,490
18551-16	1	MEMORY INCR. 16MB	200,000	11,100	600
18352-1	1	5 PP/12 CHAN. INCR	48,000	1,670	100
18352-2	1	5 PP INCREMENT	24,000	835	55
18002-1	1	SYS. CONSOLE NOS/BE	19,900	735	75
18002-2	1	SYSTEM CONSOLE	2,450	132	31
			$ 1,869,350	$ 75,072	$ 5,351

LIKELY UPGRADE COSTS: STAGE 1 completed at end of YR 2, STAGE 2 completed at end of YR 3

STAGE 1: Provides an 80% cushion for workload growth over single CPU configuration.

PRODUCT	QTY	DESCRIPTION	PRICE	LEASE	MAINT
18557-2	1	SECOND CPU	$ 855,000	$ 31,530	$ 2,700
18553-2	1	CACHE MEM. INCR. 16KB	54,000	1,670	65
			$ 909,000	$ 33,200	$ 2,765

STAGE 2: Provides additional memory capacity to support a growing number of interactive users.

PRODUCT	QTY	DESCRIPTION	PRICE	LEASE	MAINT
18551-32	1	MEMORY INCREMENT 32MB	400,000	22,200	1,200
			$ 400,000	$ 22,200	$ 1,200

WITHOUT PRICE INCREASE TOTAL PURCHASE PRICE: $ 3,178,350
WITH PRICE INCREASE OF 10% FOR STAGE 2: $ 3,218,250

LIFE CYCLE MAINTENANCE COST ESTIMATES ASSUMING 5% ESCALATION PER YEAR

YEAR	MONTHLY COST	ANNUAL COST
1	$ 5,351	$ 64,212
2	5,619	67,428
3	8,948	107,376
4	10,785	129,420
5	11,324	135,888
6	11,890	142,680
7	12,485	149,820
^	13,109	157,308
	13,764	165,168
10	14,452	173,424
TOTAL		$ 1,292,724

Figure 1-9 Hardware Alternative #2

CYBER 180/990 HARDWARE CONFIGURATION
COST ANALYSIS

STARTUP COSTS:

				MONTHLY	
PRODUCT	QTY	DESCRIPTION	TOTAL PRICE	TOTAL LEASE	TOTAL MAINT
180-990	1	CENTRAL PROC 8MB	$ 3,350,000	$120,600	$13,500
18851-1	1	MEMORY INCR. 16MB	480,000	17,300	850
18352-1	1	5 PP/12 CHAN. INCR	48,000	1,670	100
18352-2	1	5 PP INCREMENT	24,000	835	55
18002-1	1	SYS. CONSOLE NOS/BE	19,900	735	75
18002-2	1	SYSTEM CONSOLE	2,450	132	31
			$ 3,924,350	$141,272	$14,611

LIKELY UPGRADE COSTS: STAGE 1 completed at end of YEAR 6

STAGE 1: Provides additional central memory and approximately doubles system capacity. Handles workload expansion of up to approximately 400% over what can be handled by the dual 180/860 configuration.

180-990	1	SECOND CPU	$ 1,818,571	$ 62,748	$ 8,118
18551-2	1	MEMORY INCR. 24MB	480,000	17,300	850
			$ 2,298,571	$ 80,048	$ 8,968

LIFE CYCLE MAINTENANCE COST ESTIMATES ASSUMING 5% ESCALATION PER YEAR

	SINGLE CPU CONFIGURATION		DUAL CPU CONFIGURATION	
YEAR	MONTHLY COST	ANNUAL COST	MONTHLY COST	ANNUAL COST
1	$ 14,611	$ 175,332	$ 14,661	$175,332
2	15,342	184,104	15,342	184,104
3	16,109	193,308	16,109	193,308
4	16,914	202,968	16,914	202,968
5	17,760	213,120	17,760	213,120
6	18,648	223,776	18,648	223,776
7	19,580	234,960	31,598	379,176
8	20,559	246,708	33,178	398,136
9	21,587	259,044	34,837	418,044
10	22,666	271,992	36,578	438,936
TOTAL		$ 2,205,312		$ 2,826,900

Figure 1-10 Hardware Alternative #3

The workload on the central S&E Computing facility has, in the past, almost doubled over a two to three-year period (1977 to 1978-79). During the past two mainframe acquisitions, (the CDC 6600 in 1971 and the CYBER 74 in 1978) the workload has increased rapidly until the new system is saturated, then it drops off, until new hardware is acquired. This scenario is anticipated to continue, due to the increasing number of Users and their level of sophistication. Thus, long-term capacity planning is critical to satisfying the User's needs.

If a CYBER 180/850 machine is selected to start with, it is likely that an upgrade to a 180/860 configuration, along with more central memory would be required in the first year. This would be followed by adding an additional 180/860 processor, along with additional CACHE memory, by the end of the third year. If a CYBER 180/860 machine is selected to start with, it is likely that a second CPU and the CACHE memory would be required in the second year. This would be followed by a memory upgrade by the end of the third year. Roughly speaking, the 180/850 is approximately a 7-8 Million Instruction per Second (MIPS) machine configuration; the 180/860 is a 9-10 MIPS machine; and, with a second CPU, the 180/860 becomes a 14-16 MIPS machine. On the other hand, the 180/990 is approximately a 29 MIPS machine; and, in a dual CPU configuration, it becomes about a 58-62 MIPS machine.

The life cycle hardware acquisition and maintenance costs, for the first two alternatives, are approximately 4.5 million dollars. The purchase and maintenance costs for the 180/990 single CPU alternative is approximately 6.1 million dollars. In other words, almost twice the total system capacity can be acquired initially for a 1.6 million dollar impact on the anticipated life cycle cost; assuming that a single CPU 180/990 will be

sufficient to handle the future workload. The 180/990 single CPU configuration provides for up to approximately a 200% growth in workload over the dual 180/860 configuration, for considerably less than twice the total estimated life cycle cost of the dual 180/860 configuration. The purchase and maintenance costs for the 180/990 dual CPU configuration over the ten-year life cycle amount to approximately 9.05 million dollars (assuming that the second CPU is installed at the end of the sixth year). The configuration migration path from the single CPU 180/990 into a dual CPU configuration provides for up to approximately a 400% growth in workload over the capacity of the dual 180/860 configuration, for only approximately twice the cash outlay.

The risk of saturating the 180/860 dual CPU configuration over the ten-year system life cycle is HIGH. With the 180/990 the risk is MEDIUM for the one processor configuration, but LOW after the second CPU is added. With the 180/990 dual CPU, the system life cycle can be extended to fifteen years, this extension is not probable with the 180/860 route, due to the high probability of system saturation within the ten year life cycle. Clearly, in terms of total workload management the 180/990 route is preferred, if adequate funding can be acquired quickly to solve the immediate hardware maintenance problems and alleviate the current hardware limitations (lack of memory and sufficient processor speed).

Analyst support services are estimated to be about one million dollars per year, regardless of the configuration selected, over the ten-year life cycle.

b. Providing the End User equipment services to include User equipment requirements analysis, acquisition, installation, training,

maintenance, User support and consulting will require approximately three IMD personnel supported by five contractor provided personnel. The annual cost of these eight personnel is estimated to be approximately $720,000. The equipment costs cannot be estimated because these costs will be determined by actual User demands for equipment.

c. Initiation and follow-up of a public relations campaign will consume about three man-years of effort per year of IMD personnel at an estimated annual cost of $270,000 (Using a 90K man year for cost estimation).

d. Providing turnkey software support services will require a minimum of four IMD personnel supported by about eight contractor provided personnel. The actual number of resources required will be dependent upon the scope of the services, to be provided across which vendor's machines. The annualized manpower cost will be approximately $1,080,000. The acquisition cost of non-directly-reimbursed software for the mainframes is estimated to be between one and two million dollars over the ten-year period. The estimate is based upon acquisition of ten to twenty software packages at an average cost of $100,000. The life cycle cost estimate for maintenance for vendor software packages is estimated to be about 10% per year of the purchase price of the software, which amounts to about $1,500,000 to $2,000,000; depending upon when the software is actually acquired. The cost estimates for software distributed to the Users cannot be estimated, because these costs will be determined by User demands for various software packages.

e. Establishing a permanent local Demonstration and Training Facility will require a minimum of four IMD and two CPO personnel supported by about ten to fifteen contractor provided personnel. These people would form a permanent staff whose mission would be to design and execute training programs for MICOM personnel, locally in Huntsville. The annual cost of these

personnel is estimated to be between $1,440,000 and $1,890,000. The MICOM

personnel would provide guidance and management support for the center. Five

of the contractor personnel would acquire, install, operate, maintain and

support the equipment and conduct demonstrations. The other five to ten

people would develop training materials and conduct classes. The staffing

level depends, of course, on the exact nature and extent of the scope of this

center concept. A short six-month study could be conducted to develop a

detailed implementation plan for this concept if it is accepted by MICOM

Management. Hardware, software, and communications equipment acquisition,

installation, testing, operations, maintenance, support and facilities costs

should be estimated as part of the new study.

f. The IMD S&E analysis and programming staff needs to be increased

by at least ten people. The annualized cost of these people is about

$900,000. The training of these staff is estimated to cost about $10,000 per

individual or $100,000 over the ten-year life cycle. But, the actual costs

incurred might be slightly higher due to staff turnover. If these staff

cannot be acquired, more contractor support will be required.

g. The manpower requirements for overflow analysis and programming

support are estimated to be about ten man-years of effort per year, on the

average. The annual cost is estimated to be about $900,000.

h. A S&E Computer Center Workload Analysis and Management System

can be designed and implemented, using a DBMS like SIR on the CDC or FOCUS on

the PC for about $200,000 for approximately three man-years of effort.

PHASE II LIFE CYCLE COSTS

a. Developing in-house telecommunications expertise will require

that IMD develop an organizational element consisting of about five

individuals with expertise in the networking of many different types of computers. The annual cost of these resources is estimated to be $450,000.

b. Notifying the S&E Community about IMD intentions regarding S&E computing capabilities to be provided will probably take about three man-months of effort by existing IMD staff and, therefore, is not costed.

c. The additional study and design work for the overall S&E Network and Distributed Data Processing System will require a minimum of five man-years of effort to complete at a cost of approximately $450,000. The actual costs will be determined at the time of task award. The costs for the study and design will be directly related to the level of detail required in the final reports and specifications to be generated. The implementation costs and operations, maintenance, management and support costs for the S&E Network and the Hierarchical Distributed Data Processing System can only be determined after the first three tasks suggested for Phase II have been completed.

PHASE III LIFE CYCLE COSTS

a. Developing in-house expertise in supercomputer hardware and software techniques will require that IMD devote at least two to four individuals to this task. The annual cost will be $180,000 to $360,000 but will give IMD a marketable service in an expanding future market area.

b. Developing an in-house capability to convert standard scientific and engineering codes to vector codes and developing some conversion tools can be accomplished by using the resources dedicated for item (a.) above. Therefore, no separate costs are identified.

c. The in-house expertise in supercomputers will probably require augmentation by about five contractor provided personnel. The estimated annual cost is $450,000.

d. A study to determine the actual S&E Supercomputer requirements

will have to be conducted before detailed cost estimates can be made for the augmentation of the MICOM S&E Center with a Hardware Vector Processing Capability. The study can be conducted by the staff identified for items (a.) and (c.) above. In the meantime, the Army Supercomputer will have to be accessed through a IMD provided data link. The eventual cost of acquiring a Supercomputer will be between 10 and 24 million dollars; operations, maintenance and support will cost about 1 million dollars per year.

PHASE IV LIFE CYCLE COSTS

a. Establishing a new technology assessment capability will require that IMD dedicate at least two individuals to perform this function. The annualized cost is estimated at $180,000.

b. Long-range strategic planning efforts will consume about three man-years of effort per year at an annual cost of $270,000.

c. Contractor support for new technology assessment and for providing inputs to long-range strategic planning efforts is estimated to be about four man-years of effort per year, at an annual cost of $360,000.

d. No additional IMD or contractor resources are required to get the key User groups involved in long-range strategic planning efforts. The resources ident_fied in items (a.) through (c.) above will interface with the key User groups on a regular basis as part of their tasks.

PHASE V LIFE CYCLE COSTS

Providing turnkey hardware, software and telecommunications service solutions to meet unique User Requirements will require a mix of about four IMD and about four contractor provided personnel. The estimated annual cost is $720,000. Additional costs would be determined for each unique requirement as they arise.

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